REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
09/00/76

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
INTERIM CONTAINMENT SYSTEM GROUNDWATER TREATMENT ROCKY MOUNTAIN ARSENAL, DENVER COLORADO, FINAL REPORT

5. FUNDING NUMBERS

6. AUTHOR(S)
MILLER, S.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
ARMY ENGINEER WATERWAYS EXPERIMENT STATION. SOILS AND PAVEMENTS LABORATORY
VICKSBURG, MS

8. PERFORMING ORGANIZATION REPORT NUMBER
81266R50

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
EDGEWOOD ARSENAL (MD.)
MARYLAND

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
WES HAS BEEN REQUESTED TO EVALUATE INTERIM SYSTEMS FOR CONTAINMENT/DEWATERING/RECHARGING OF CONTAMINATED GROUNDWATER AT RMA. WES WAS ALSO TASKED TO PLAN ACQUISITION AND EVALUATION OF GEOTECHNICAL DATA FOR DEVELOPMENT OF DESIGN CRITERIA FOR THE CHOSEN SYSTEM.

14. SUBJECT TERMS
DEWATERING WELLS, SOIL PROPERTIES, PUMPING TESTS

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

INTERIM CONTAINMENT SYSTEM GROUNDWATER TREATMENT ROCKY MOUNTAIN ARSENAL DENVER, COLORADO

by

S. P. Miller

September 1976
Final Report

Prepared for Decontamination Systems Technical Working Group, Edgewood Arsenal, Maryland

Conducted by U. S. Army Engineer Waterways Experiment Station
Soils and Pavements Laboratory
Vicksburg, Mississippi

PREFACE

This investigation was conducted during the period 17 May 1976 to 30 September 1976 by the Soils and Pavements Laboratory (S&PL) of the U. S. Army Engineer Waterways Experiment Station (WES). The study was authorized by IAO BT004, Aberdeen Proving Ground, Maryland, dated 13 July 1976 and IAO RM-56-7T, Rocky Mountain Arsenal (RMA), Denver, Colorado, dated 16 August 1976.

This report was prepared by Mr. S. P. Miller of the Engineering Studies Branch, S&PL, WES, under the supervision of Mr. G. B. Mitchell, Chief, Engineering Studies Branch. Mr. C. L. McAnear was Chief, Soil Mechanics Division, and Mr. J. P. Sale was Chief, S&PL. Mr. W. O. Miller and Mr. W. L. Murphy of the Engineering Geology and Rock Mechanics Division, S&PL, developed parts of the project design criteria.

The assistance of personnel at RMA is gratefully acknowledged.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES during the preparation of this report. Mr. F. R. Brown was Technical Director.

CONTENTS

INTERIM CONTAINMENT SYSTEM, GROUNDWATER TREATMENT
ROCKY MOUNTAIN ARSENAL, DENVER, COLORADO

Introduction

Background

1. The Decontamination Systems Technical Working Group, Aberdeen Proving Ground, Maryland, at the direction of the Program Manager, Installation Restoration, requested the U. S. Army Engineer Waterways Experiment Station (WES) to evaluate interim systems for containment/dewatering/recharging of contaminated groundwater at Rocky Mountain Arsenal (RMA). The WES was also tasked to plan acquisition and evaluation of geotechnical data for development of design criteria for the chosen system. This report does not address the treatment portion of the interim containment system.

Purpose and scope

2. This report will be used to develop the conceptual system into a project for construction and operation. After consideration of various system components in relation to several factors, e.g., geotechnical data, geochemical data, constraints, costs, the system described herein was selected. This report describes the chosen site, geotechnical data acquired, and system components selected, and provides design criteria for the system. The site chosen for the interim containment system is along part of the northern boundary of RMA near a small pond-like area primarily fed by groundwater and referred to as the "bog," Figures 1 and 2.

3. The objective of the interim containment system is to intercept the groundwater flowing northerly across the alignment of the system, treat it, and return it to the aquifer downstream of the dewatering component. with min. disturb. of gnd wtr regime This system will consist of four major components: dewatering wells, a groundwater barrier, a recharge component, and a treatment component, Figure 3. The dewatering wells will remove water from the aquifer and the recharge component will return it to the aquifer. To avoid

movement of treated, recharged water back to the dewatering area, which would increase the volume of water to be treated, a barrier will be installed between the dewatering wells and the recharge component. Another use of the barrier will be to provide temporary underground storage of water to permit maintenance or repair of the treatment facilities without permitting contaminated groundwater to travel beyond the barrier.

Site Conditions

Geology

4. The geology of RMA consists of unconsolidated alluvial terrace deposits and eolian sand of ~~Recent to~~ Quaternary age overlying bedrock of clay shales and sandstone of the Cretaceous ~~Dawson~~ ~~Denver~~ Denver Arapahoe formation. Small bedrock outcrops occur on a few of the hills within the Arsenal. Near the northern boundary, bedrock is predominantly clay shale overlain by 20 to 30 ft of terrace sands and gravels and eolian clays and sands. ~~The interim system will be concerned only with the bedrock and materials above.~~ Topography is gentle with elevations in the system area varying from approximately 5130 MSL to 5160 MSL. Remnants of ancient terraces form low hills in the area.

Groundwater

5. The shallow aquifer consists of alluvial materials overlying the bedrock. The aquifer and water table elevations have been charted in several publications.[1,2,3] Water levels taken from borings during the subsurface site investigation are recorded on the soil profiles, Plates 1-7. The water level is steady with minor seasonal variations. Saturated thickness in the site area varies from 10 to 25 ft, Plates 1-7, and the gradient is approximately 0.01 to 0.005 toward the north.[1,2] The bottom of the bog apparently intercepts the groundwater table and is supplied directly from the aquifer. This interpretation is substantiated by observation, borings, and bulk sampling in the bog area.

Subsurface investigation

6. The subsurface investigation consisted of 24 borings drilled in July 1976 and presented in Plates 1-7 which give boring locations and soil profiles. Samples were taken at 5-ft increments and/or change in stratum. Three different types of borings were made: undisturbed (UD), drive (D), and auger (A). Samples from the 8 UD borings were taken with a 3-in.-diam open Shelby tube in cohesive soils and with a 2-in. split spoon for cohesionless soils. The 2-in. split spoon was used for all soils encountered in the 8 D borings. Jar samples were taken and blow counts recorded for all drive samples. The 8 A borings were visually classified. All borings penetrated the weathered zone of the bedrock and all samples were transported to the WES for classification and testing.

Soil properties

7. The overburden soils are generally lean clays (CL) overlying sands (SC, SP) which, in turn, overlay the weathered shale (usually a fat clay CH or inorganic silt MH) or weathered sandstone (usually lean clay and silty sand CL-SM or silty sand SM) above the unweathered bedrock. This general trend is apparent from the soil profiles, Plates 1-7, which are classified from the boring logs.

8. Soil samples from the subsurface investigation were tested at the WES Soils and Pavements Laboratory (S&PL) to determine index properties and strengths. Grain size distribution curves, laboratory classifications, liquid limits (LL), plastic limits (PL), plastic indexes (PI), and water contents for samples from UD and D borings are shown on Plates 17 18-80. Unconsolidated, undrained triaxial tests were performed on selected UD samples, Plates 9-16. A Unified Soil Classification and legend are provided in Plate 8.

Pumping tests

9. Three pumping tests were made in the alignment areas, Figure 2, during August 1976 by the WES S&PL to determine local permeability and yield characteristics of the aquifer. Analysis of these tests gave a permeability of approximately 210 ft per day, which was used with gradient and aquifer cross sectional area to calculate groundwater flow across the system alignment.

Major System Components and Associated Design Criteria

Dewatering wells

10. A dewatering system to remove the contaminated water from the aquifer for treatment is shown in Figure 4. The dewatering alignment should be located 200 ft from the barrier and be 1400 ft in length. It is positioned between Station 26+00 and 40+00 of the original stationing of the north and south aligments as shown in Plates 1-7. Normal northerly groundwater flow across this alignment is expected to be 135 gallons per minute (gpm). Since this flow is expected to fluctuate, the maximum capacity of the dewatering system should be 125 percent of expected flow, or 169 gpm. This is the approximate expected capacity of the treatment component. The dewatering system should also have the capability to evenly remove the minimum flow of 75 percent of normal, or 100 gpm. Therefore the separate wells must be capable of handling a variation in flow due to these fluctuations and also due to local differences in flow along the alignment. The wells must fully penetrate the aquifer with well screen length equal to aquifer thickness. A general well spacing of 200 ft was chosen. This spacing has been varied to accommodate nonuniform flow across the dewatering alignment and should result in approximately 5 ft of drawdown in the wells. Pumps should have automatic controls to maintain a set drawdown once the required drawdown to operate the system is established. The distance between the barrier and dewatering alignment is set to make optimum use of undergound storage as described in paragraph 11 and Figure 5. Figure 4 presents the dewatering and barrier alignments in plan and the dewatering alignment in profile, west to east. Figure 5 is a schematic cross section of the entire system, south to north. The grain size curves provided as Plates 17-80 can be used for sizing of well screen openings.[4]

Groundwater barrier

11. A groundwater barrier consisting of a bentonite slurry cutoff trench extending into the bedrock should be located from Station 26+00 to 40+00 of the northern system alignment, Plate 2, as shown in Figure 4.

This barrier will block movement of treated water from the recharge area back to the dewatering wells, thus preventing recycling of water in the treatment process. The barrier will also provide underground storage as shown schematically in Figure 6. This potential storage could be used during periods of dewatering system shutdown for maintenance problems or treatment delay. The total amount of storage is approximately 400,000 gallons which would be 2 days flow at the normal expected flow of 135 gpm. This amount assumes well drawdown as shown in Figure 4 and a porosity of 0.40 in the storage strata.

12. The slurry should be a mixture of bentonite, water, and any desired additives, and will serve to stabilize the trench during excavation.[6,7,8] The trench should extend 2 ft into weathered bedrock (CH) in clay shale areas and to the bedrock in sandstone areas, be a minimum of 24 in. in width, and have a structural cover. A structural cover is required to carry any load applied on or in the immediate vicinity of the slurry trench (e.g. traffic or working platforms) since it cannot support a load. The trench should be 1400 ft in length and an average of 27 ft in depth. These are approximate dimensions based on limited soil sampling, therefore determination of actual construction dimensions should be made by a knowledgeable soils engineer based on field conditions encountered during construction. Specifications should be developed defining water quality factors such as pH, hardness, and deleterious substances. Industrial suppliers of bentonite have guides for desired slurry water quality. If neither local well water nor the bog water meets these standards, alternative sources of water should be considered. A model study was conducted to discover if the groundwater in the system area would have any detrimental initial gross effects on the bentonite.[5] The study lasted 10 days using groundwater from the interim containment system area. No detrimental effects were noted.

<u>Recharging component</u>

13. The treated water must be restored to the aquifer through a recharge method downstream (north) of the barrier. The bog area presents a natural and readily accessible entrance to the aquifer. The rate of movement of the recharged water in the aquifer will vary

with the head maintained in the bog. In order to use the bog for recharge, all fine-grained material in the bottom of the bog above the aquifer should be removed. From consideration of aquifer area, aquifer permeability, and required gradient, the bog area should be able to recharge the aquifer at the maximum dewatering/treatment rate of 169 gpm, with approximately 1 ft of head above natural groundwater level. Lower areas of the bog boundary may require a dike to accommodate this water level. It is assumed that the treated water will be of relatively high quality and should pose only a minor, if any, clogging problem in the recharge area.

14. If the bog is retained in its present configuration for recharge, excavation is expected to be approximately 12,000 cu yd based on the soil borings. Actual quantity should be determined by a knowledgeable inspection of the bog to insure removal of all fine-grained material above the aquifer. This excavated material could be used to form part of the small dike referred to in paragraph 13. Side slopes of the excavation and/or dike should not exceed 1 vertical on 2 horizontal.

General considerations

15. Further considerations in the design of the interim containment system must include provision for above-ground storage of water to handle short-term differences in pumping and treatment rates and other contingencies, and a system to transport water from the dewatering system to the treatment location and, after treatment, back to the recharge area. These designs should consider such factors as safety, effect of contaminents on all components, treatment location, and cold weather precautions.

16. Monitoring of the groundwater system prior to and during construction and operation is necessary to assess the effectiveness of the system and provide input to operational variables, e.g. pump rates, recharge rates. Obviously, water quality and location must be closely observed. This need can be accomplished by installing observation wells and incorporating existing observation wells into a monitoring program for the interim containment system. It is important that this

program be initiated as soon as possible to establish general groundwater quality and level prior to construction and operation of the interim containment system. This, with existing data, will establish conditions prior to intervention by the system.

17. Observation wells capable of providing water level measurements and water quality sampling should be installed. Elevations of the tops of riser pipes should be established and protection from damage and contamination provided for during construction and operation. Any necessary access requirements for the installation or reading of new or existing observation wells located off the Arsenal should be considered. Records of water level and quality should include the bog (recharge component) and the dewatering wells. Readings of water level should be made biweekly prior to and during construction, daily during initial system operation, and over longer time periods as a stable condition develops. Water samples should be taken as necessary to determine the effect of the interim containment system on water quality.

18. Figure 7 depicts a plan for placing observation wells for use in a monitoring program. The observation wells are listed in Table 1 by number and purpose. Readings from these wells, the bog, and the dewatering wells may be used to produce groundwater elevation and quality contour maps and groundwater elevation cross sections to interpret the effect of the interim containment system on the groundwater and determine operational variables such as pumping rates and recharge rate. This plan may require adjustment or additional observation points as monitoring requirements develop.

REFERENCES

1. Konikow, L. F., Hydrogeologic maps of the alluvial aquifer in and adjacent to the Rocky Mountain Arsenal, Colorado: U. S. Geol. Survey open file report 74-342, 1 sheet, 1975.

2. U. S. Army Engineer District, Omaha, Nebraska, "Program for Reclamation of Surface Aquifer, Rocky Mountain Arsenal, Denver, Colorado," February 1961.

3. Robson, S. G., "Model Study of Diisopropylmethylphosphonate (Dimp) Contamination, Rocky Mountain Arsenal near Denver, Colorado, Progress Report--Phase I," U. S. Geological Survey, Denver, Colorado, February 1976.

4. Departments of the Army, Navy, and Air Force, "Dewatering and Groundwater Control for Deep Excavations," TM 5-818-5, April 1971.

5. U. S. Army Engineer Waterways Experiment Station, "Comments on Imperviousness of Slurry Trench - Interim Containment System - Rocky Mountain Arsenal," letter 2 September 1976.

6. Xanthakos, Petros P., <u>Underground Construction in Fluid Trenches</u>, Chicago, April 1974.

7. Boyes, R.G.H., <u>Structural and Cut-Off Diaphragm Walls</u>, Wiley, New York, 1975.

8. Stanley Consultants, Inc., and Woodward-Clyde Consultants, "Lake Chicot Pumping Plant, Letter Report, Slurry Trench," August 1975.

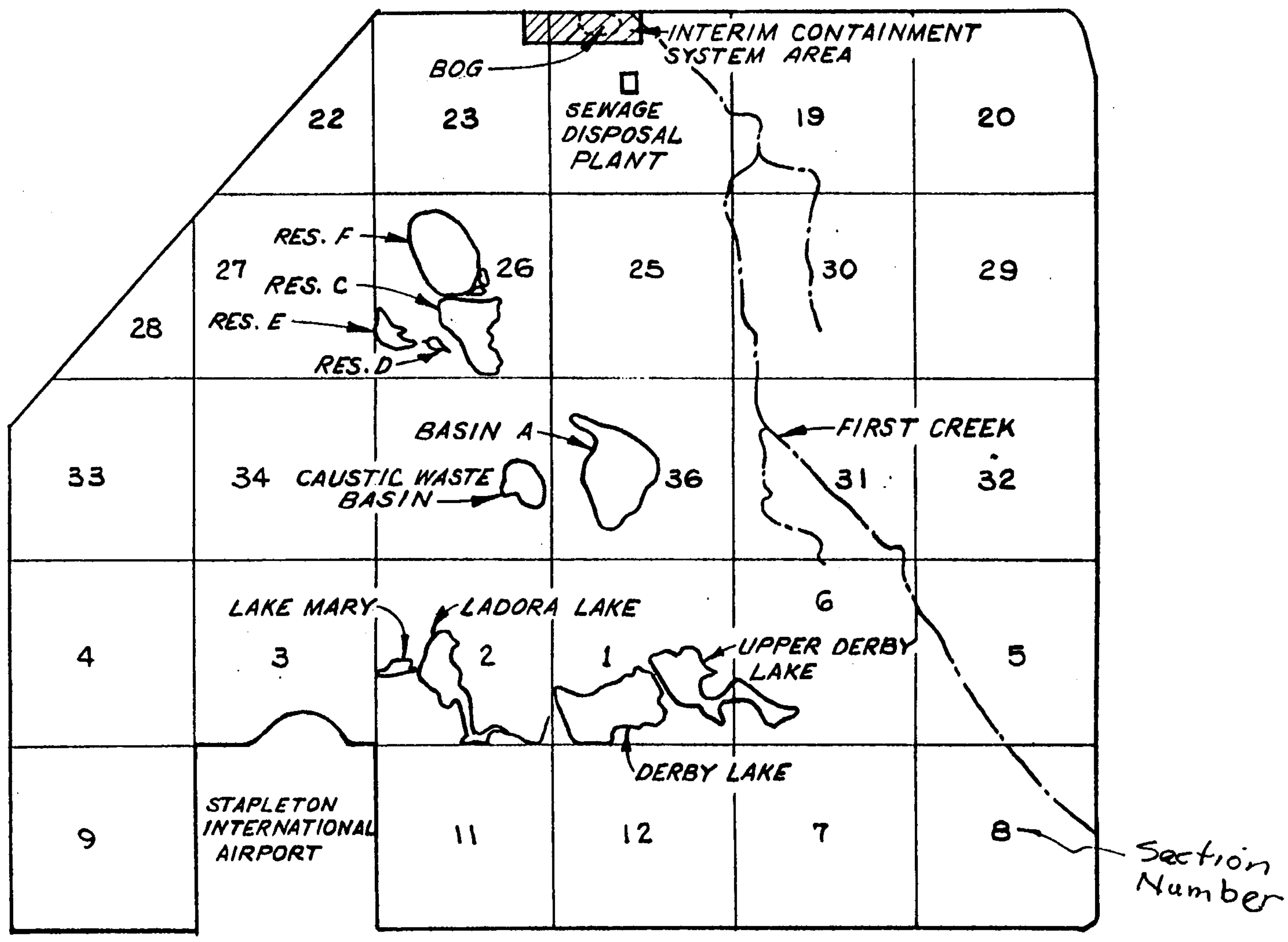


Figure 1. Interim Containment System location - Rocky Mountain Arsenal, Denver, Colorado

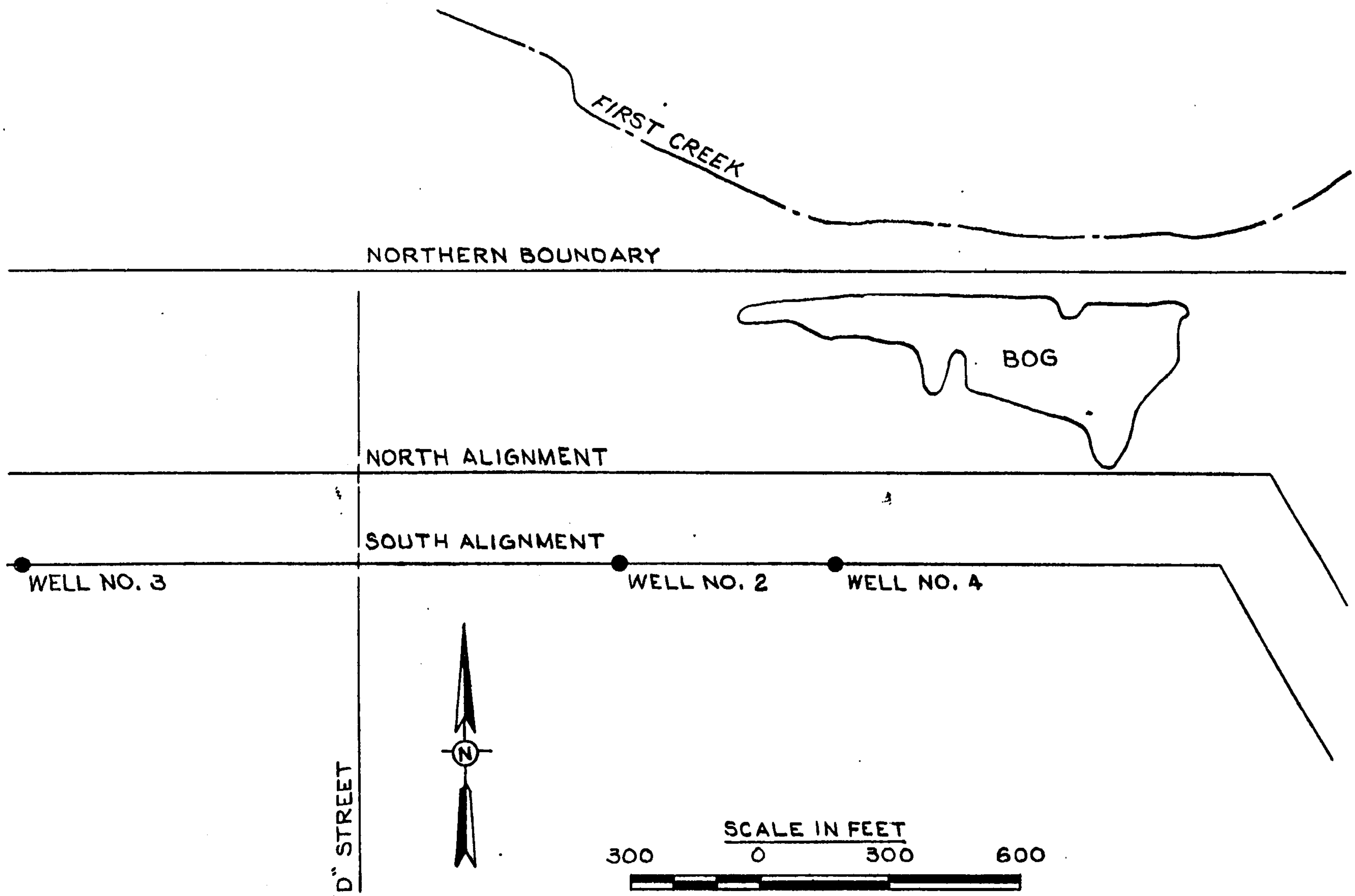


Figure 2. Subsurface investigation alignments and pumping test locations

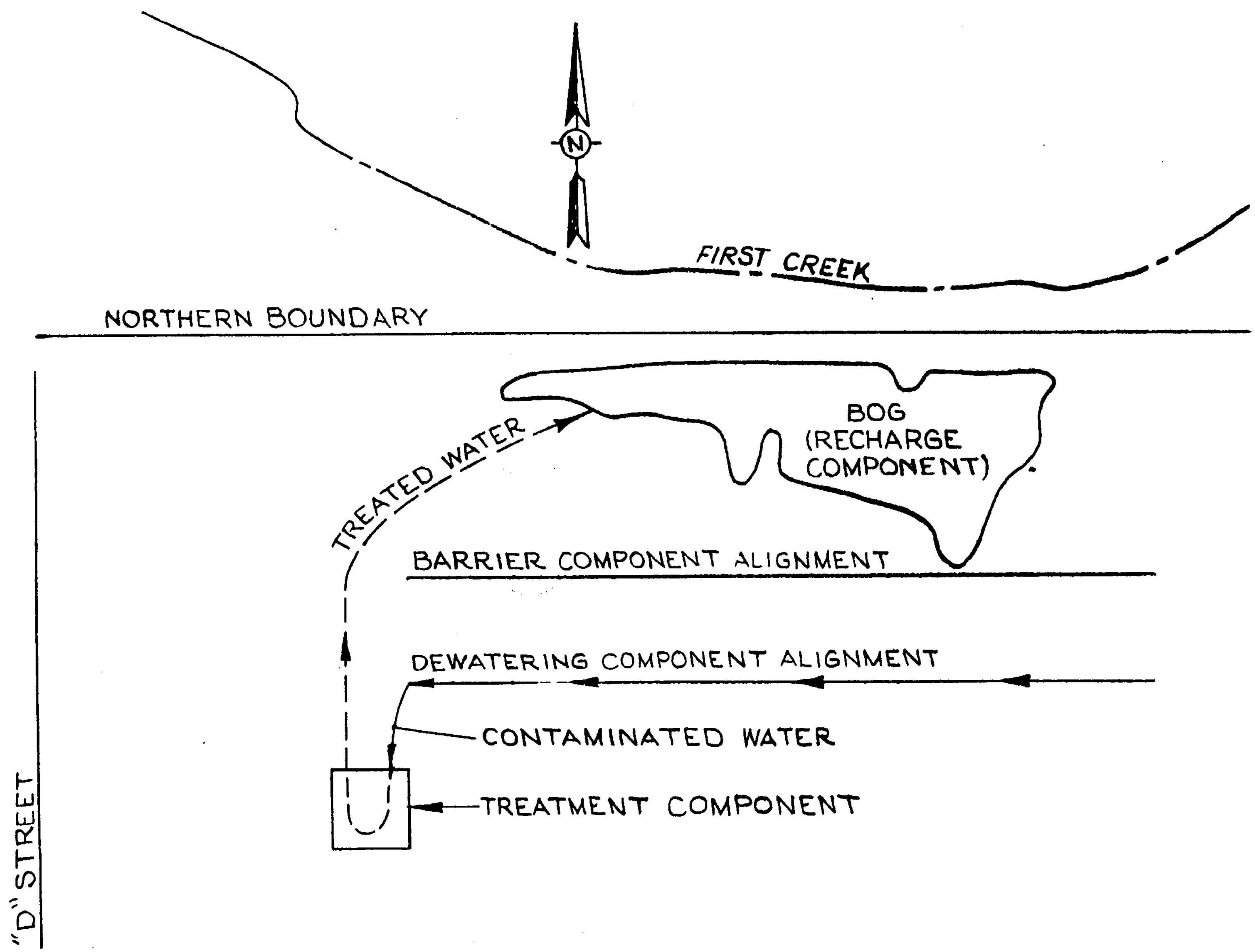


Figure 3. Interim Containment System components

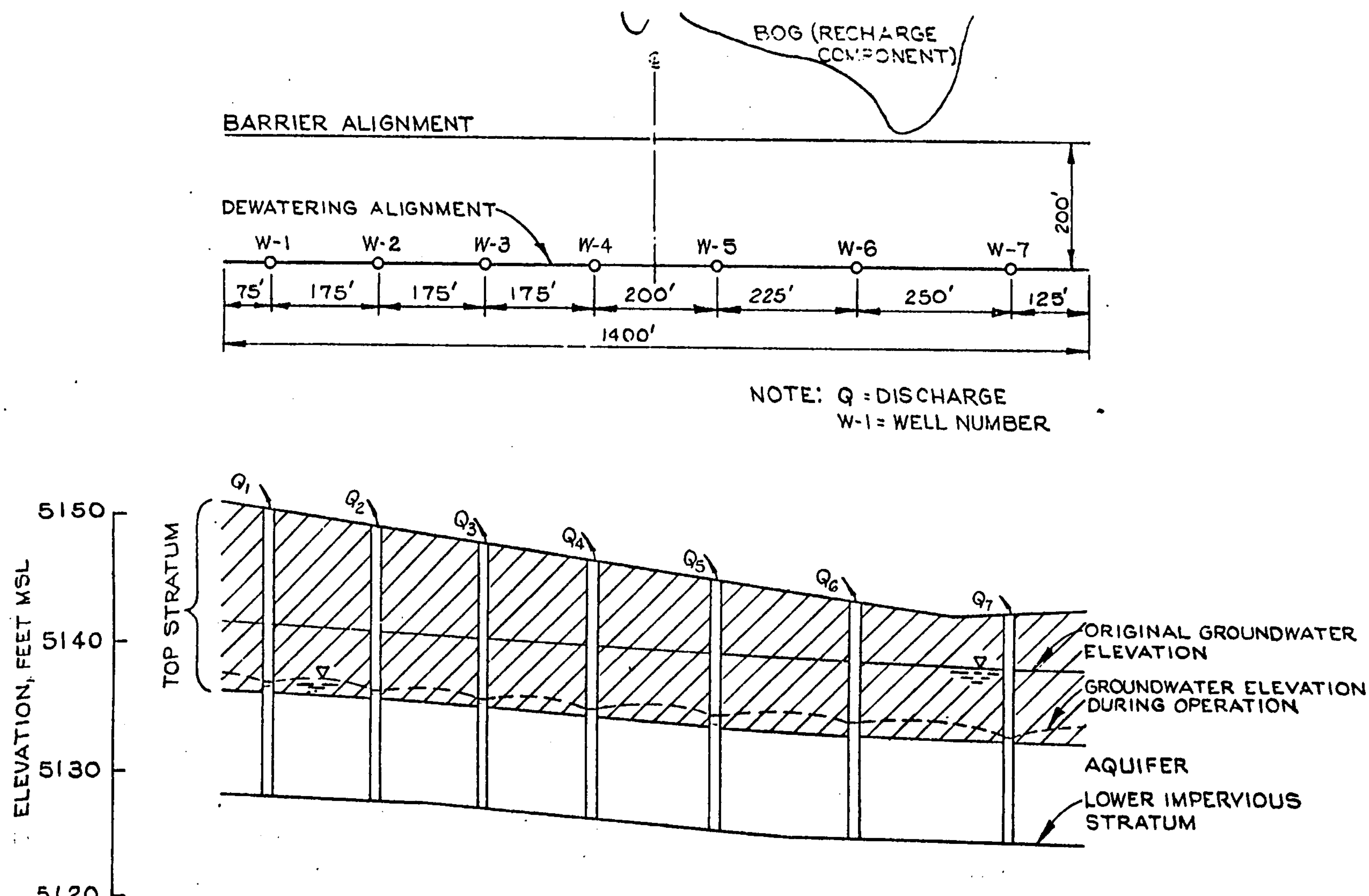


Figure 4. Plan and profile of dewatering alignment

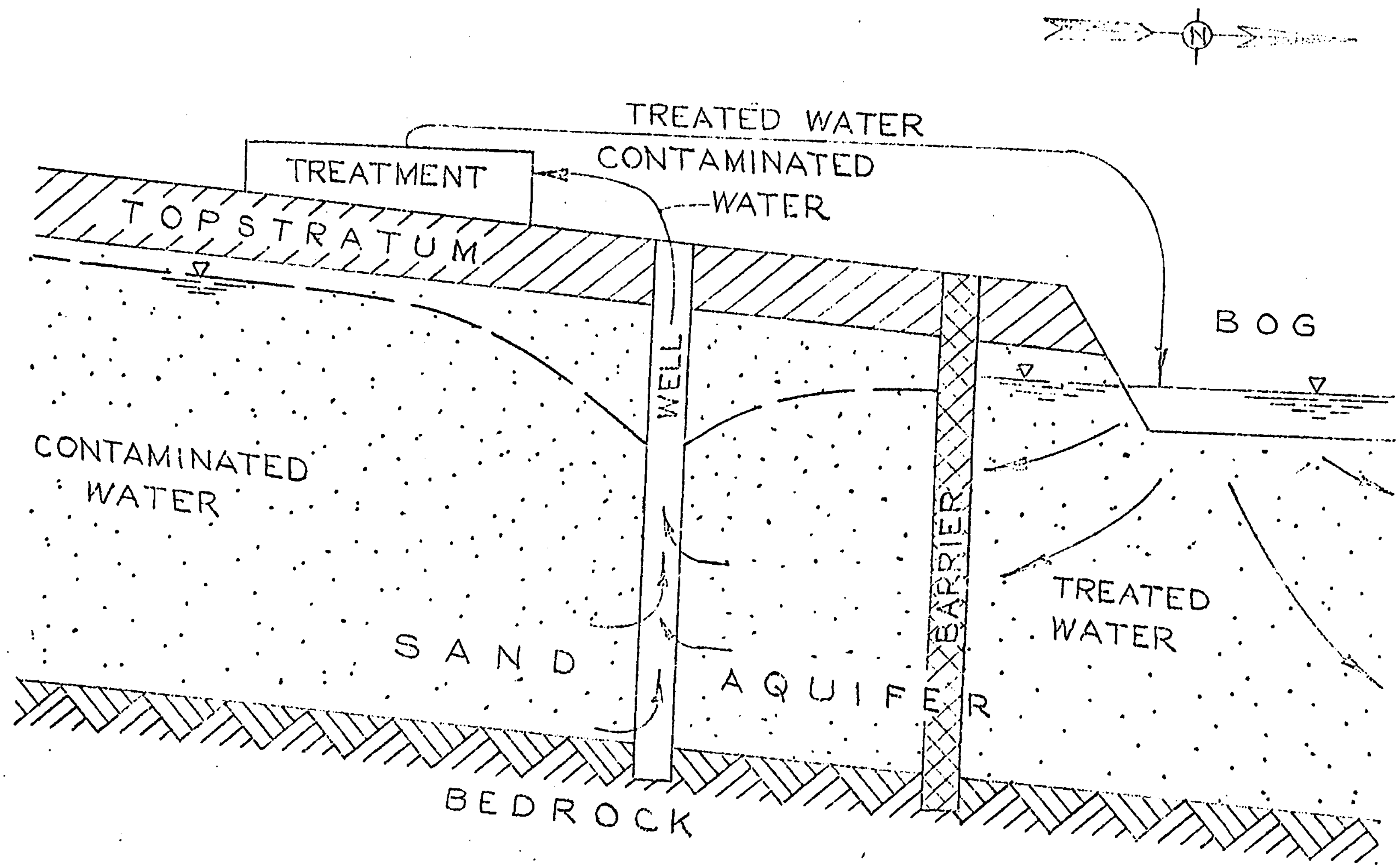


Figure 5. Schematic diagram of Interim Containment System, RMA

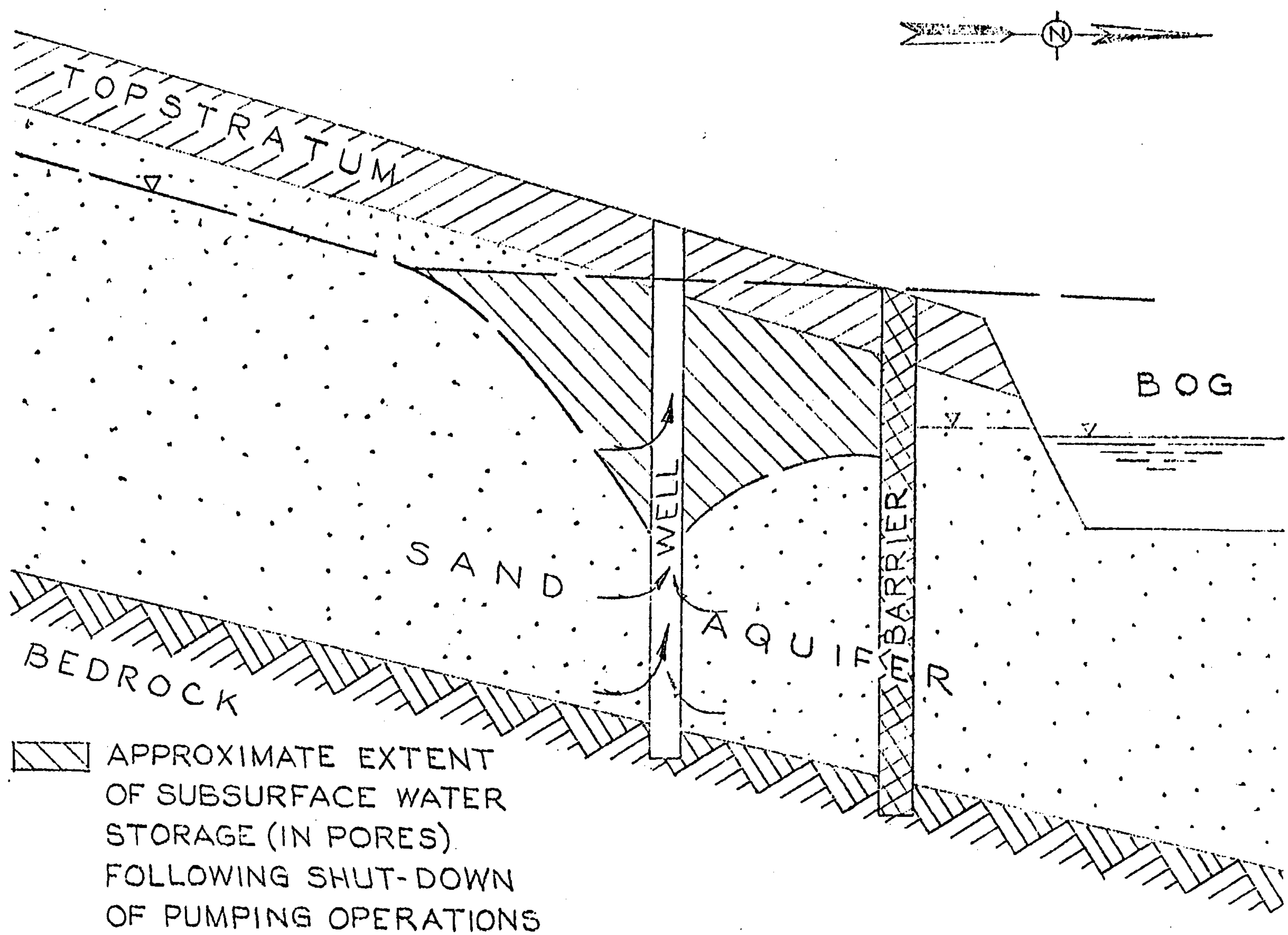


Figure 6. Schematic diagram of Interim Containment System subsurface water storage, RMA

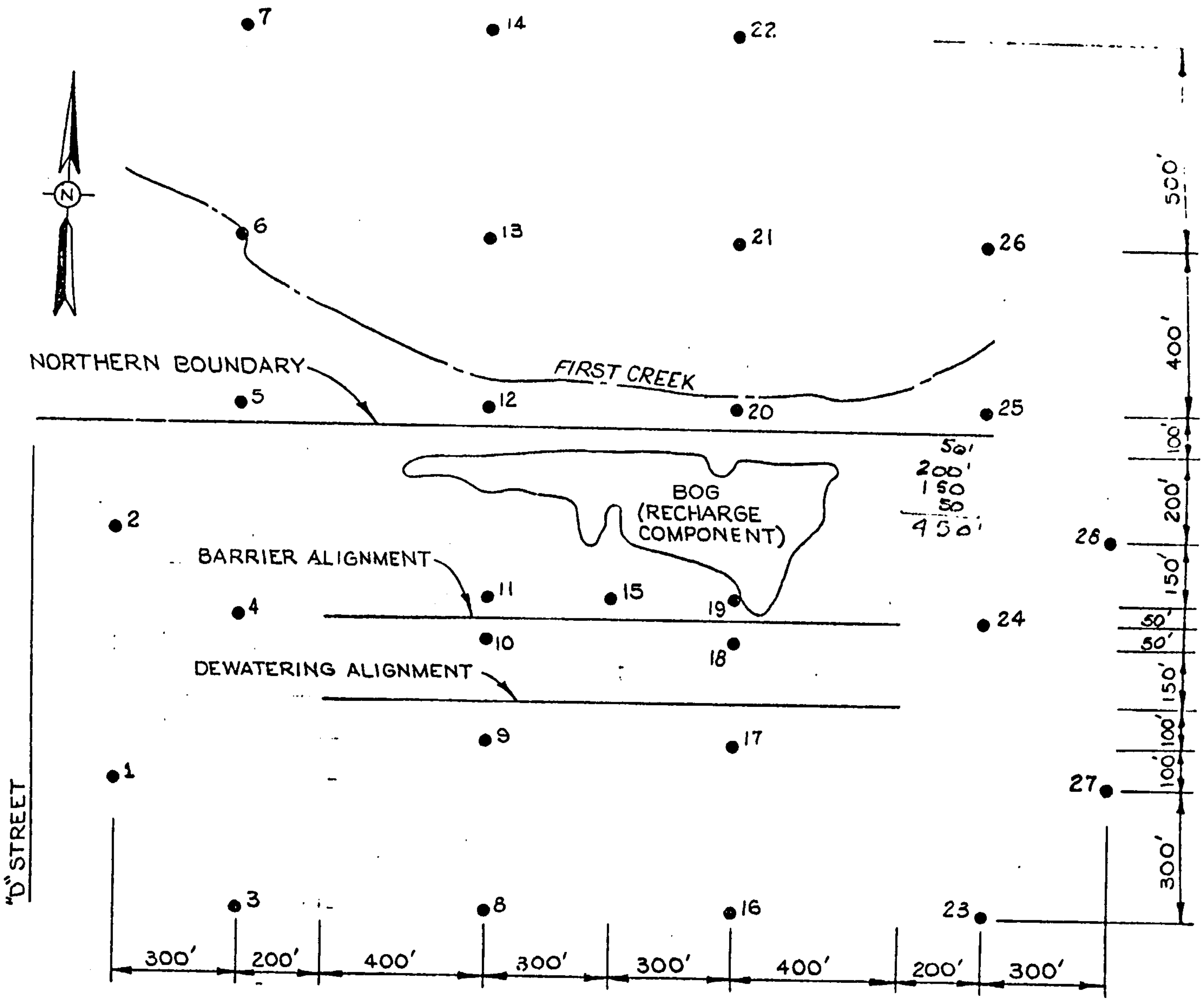
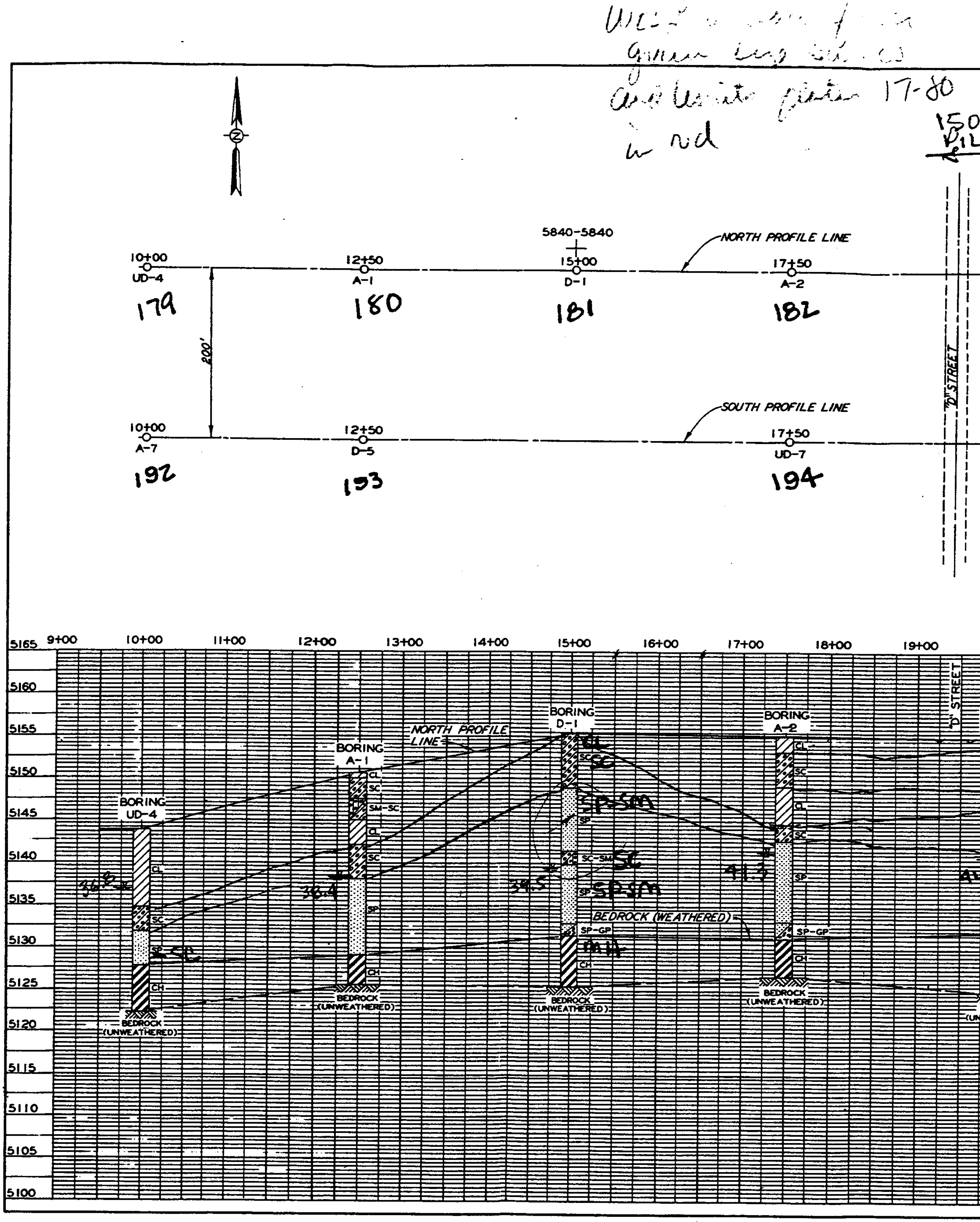


Figure 7. Groundwater monitoring plan



17-80
5840-5840
NORTH PROFILE LINE
10+00
UD-4
179
12+50
A-1
180
15+00
D-1
181
17+50
A-2
182
200'
"D" STREET
SOUTH PROFILE LINE
10+00
A-7
192
12+50
D-5
193
17+50
UD-7
194
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
"D" STREET
BORING UD-4
BORING A-1
BORING D-1
BORING A-2
NORTH PROFILE LINE
CL
SC
SM-SC
SP
CH
SC-SM
SP-GP
SP-SM
BEDROCK (WEATHERED)
BEDROCK (UNWEATHERED)
36.8
38.4
39.5
41.5

Usito plates 17-80

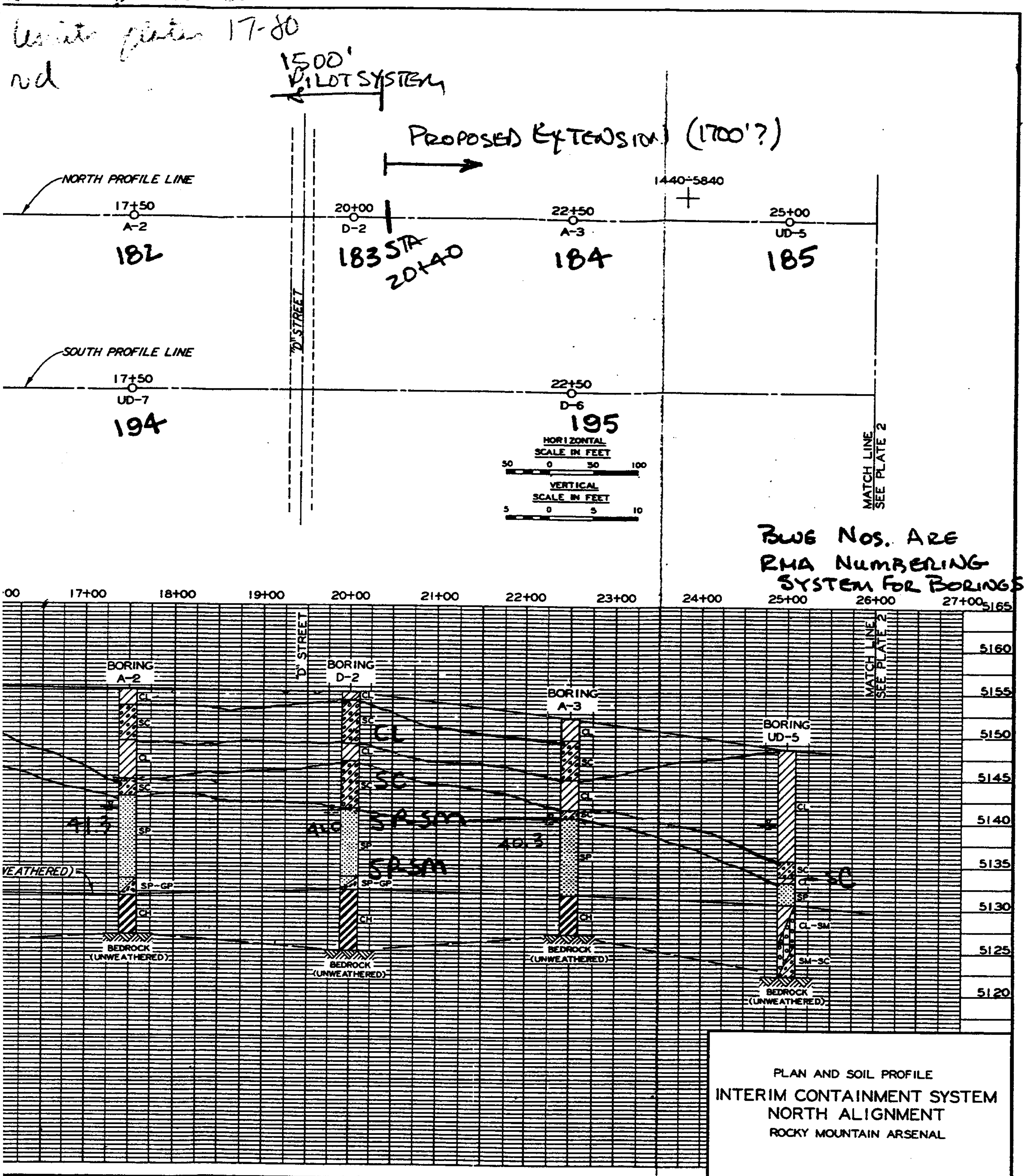
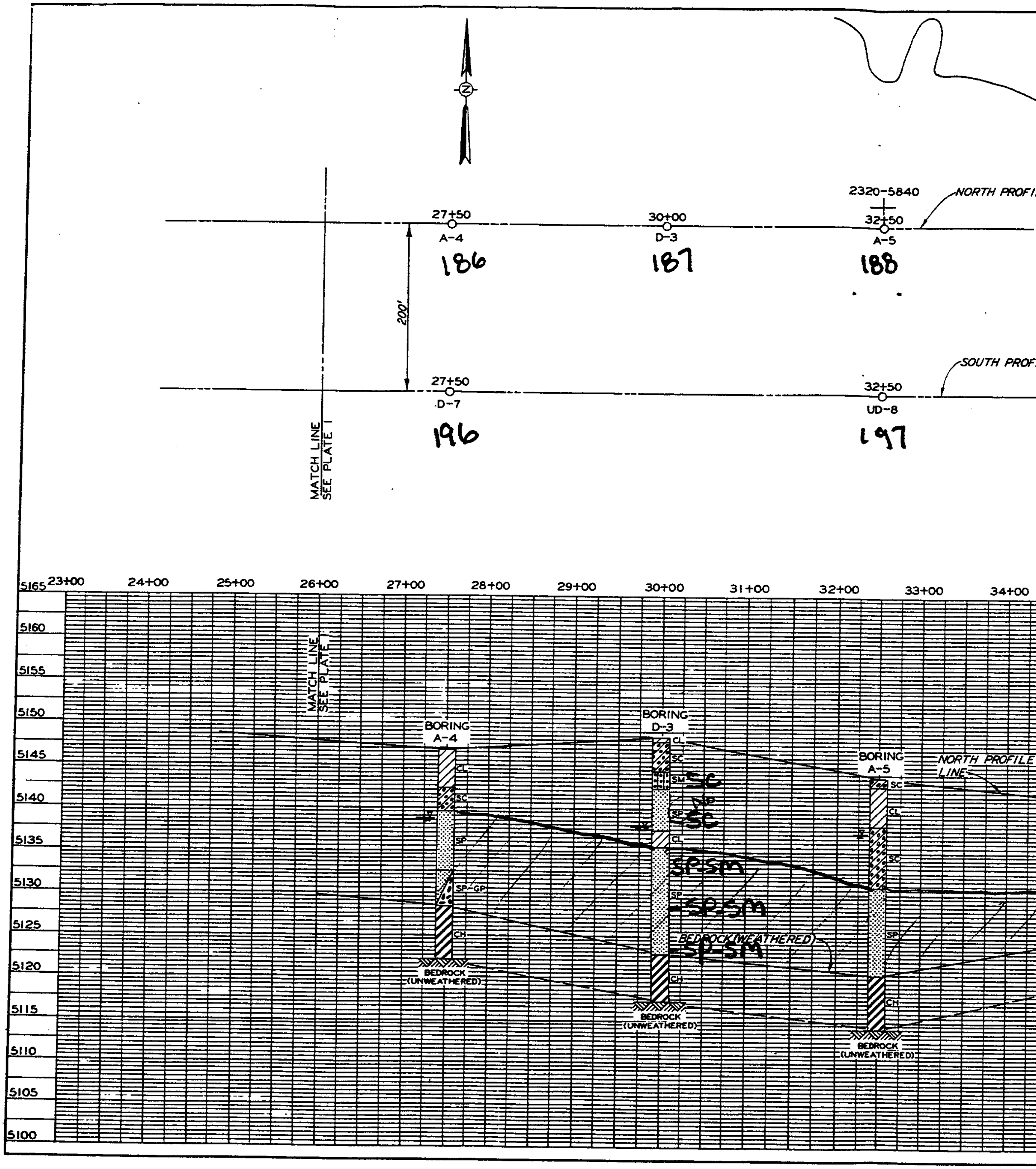
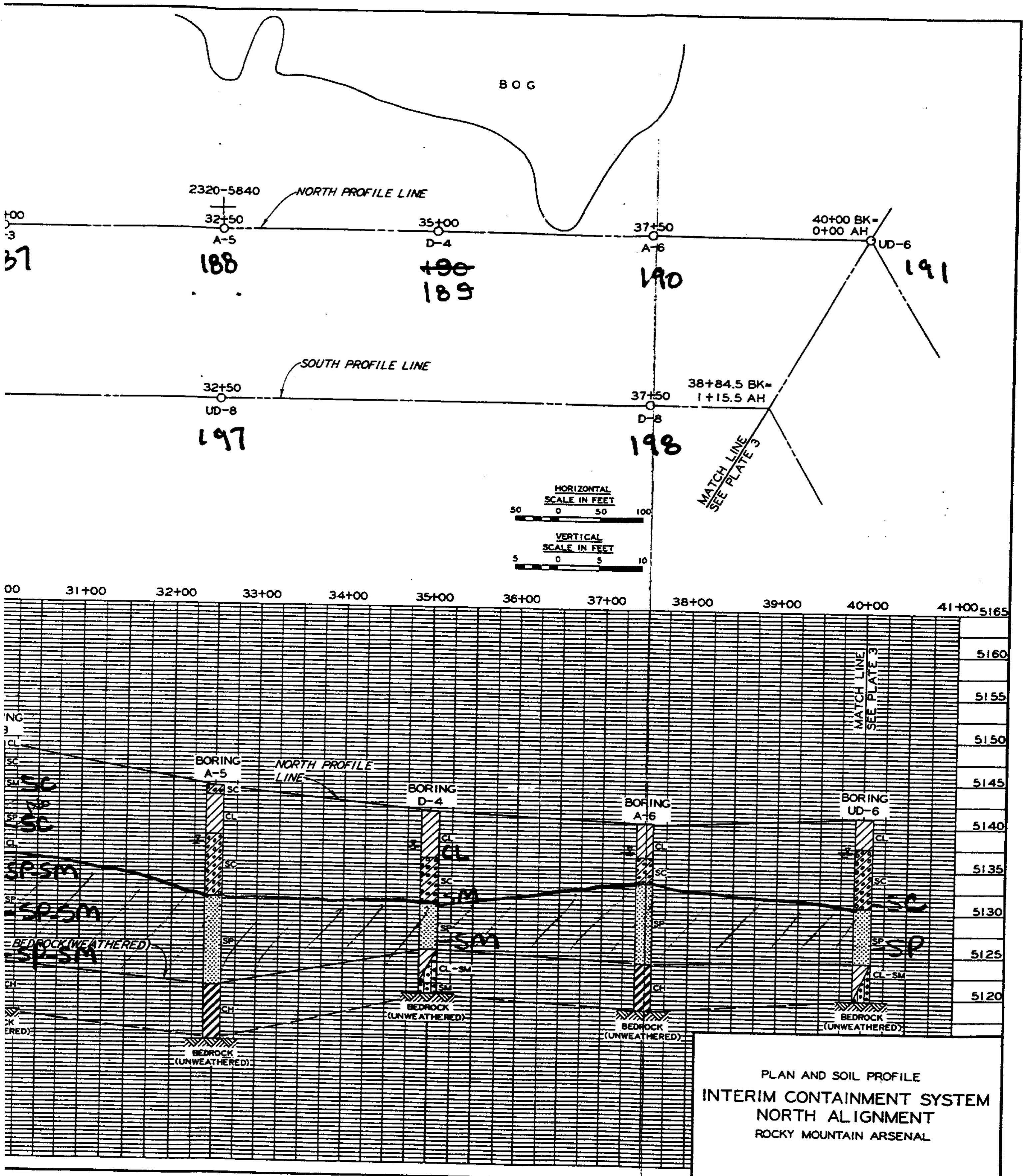


PLATE 1

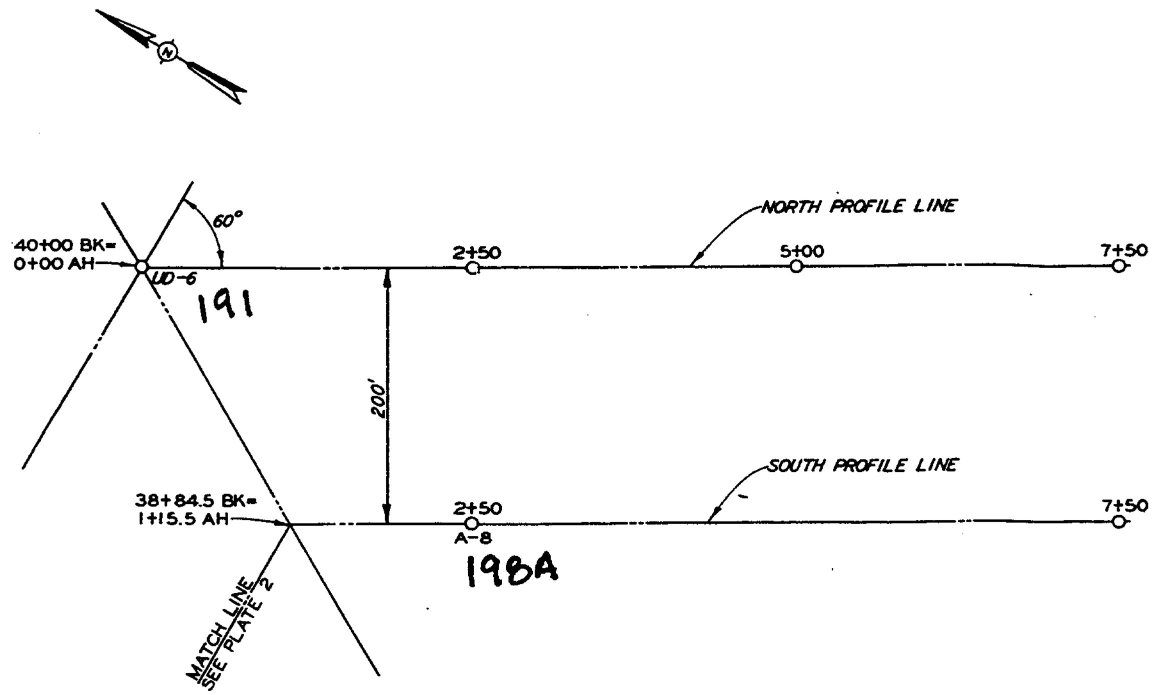


2320-5840
NORTH PROFILE
27+50
A-4
186
30+00
D-3
187
32+50
A-5
188
200'
SOUTH PROFILE
27+50
D-7
196
32+50
UD-8
197
MATCH LINE
SEE PLATE I
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
MATCH LINE
SEE PLATE I
BORING
A-4
CL
SC
SP
SP-GP
CH
BEDROCK
(UNWEATHERED)
BORING
D-3
CL
SC
SM
SC
SP
SC
CL
SP-SM
SP
SP-SM
BEDROCK (WEATHERED)
SP-SM
CH
BEDROCK
(UNWEATHERED)
BORING
A-5
SC
CL
SC
SP
CH
BEDROCK
(UNWEATHERED)
NORTH PROFILE
LINE

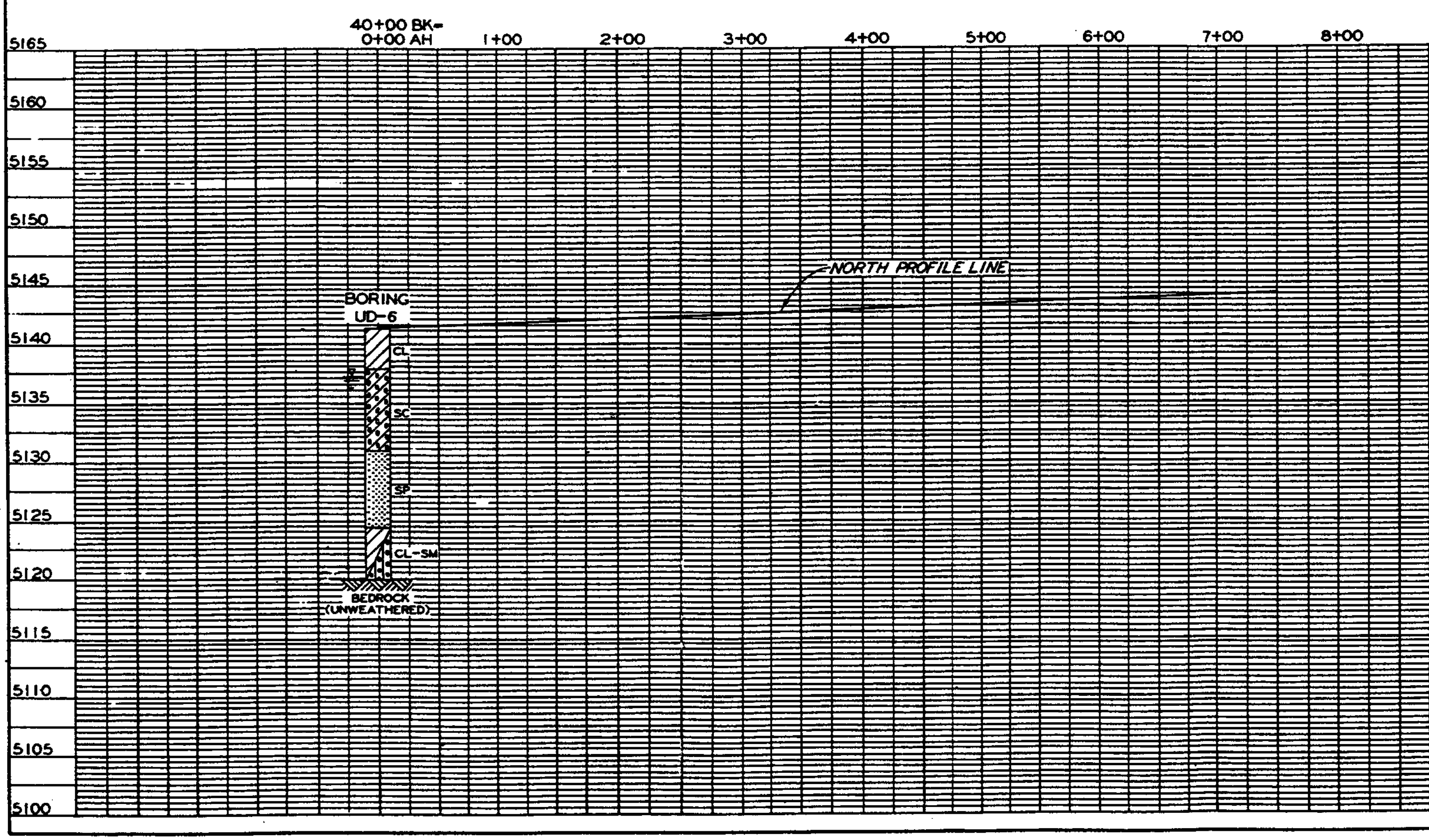


PLAN AND SOIL PROFILE
INTERIM CONTAINMENT SYSTEM
NORTH ALIGNMENT
ROCKY MOUNTAIN ARSENAL

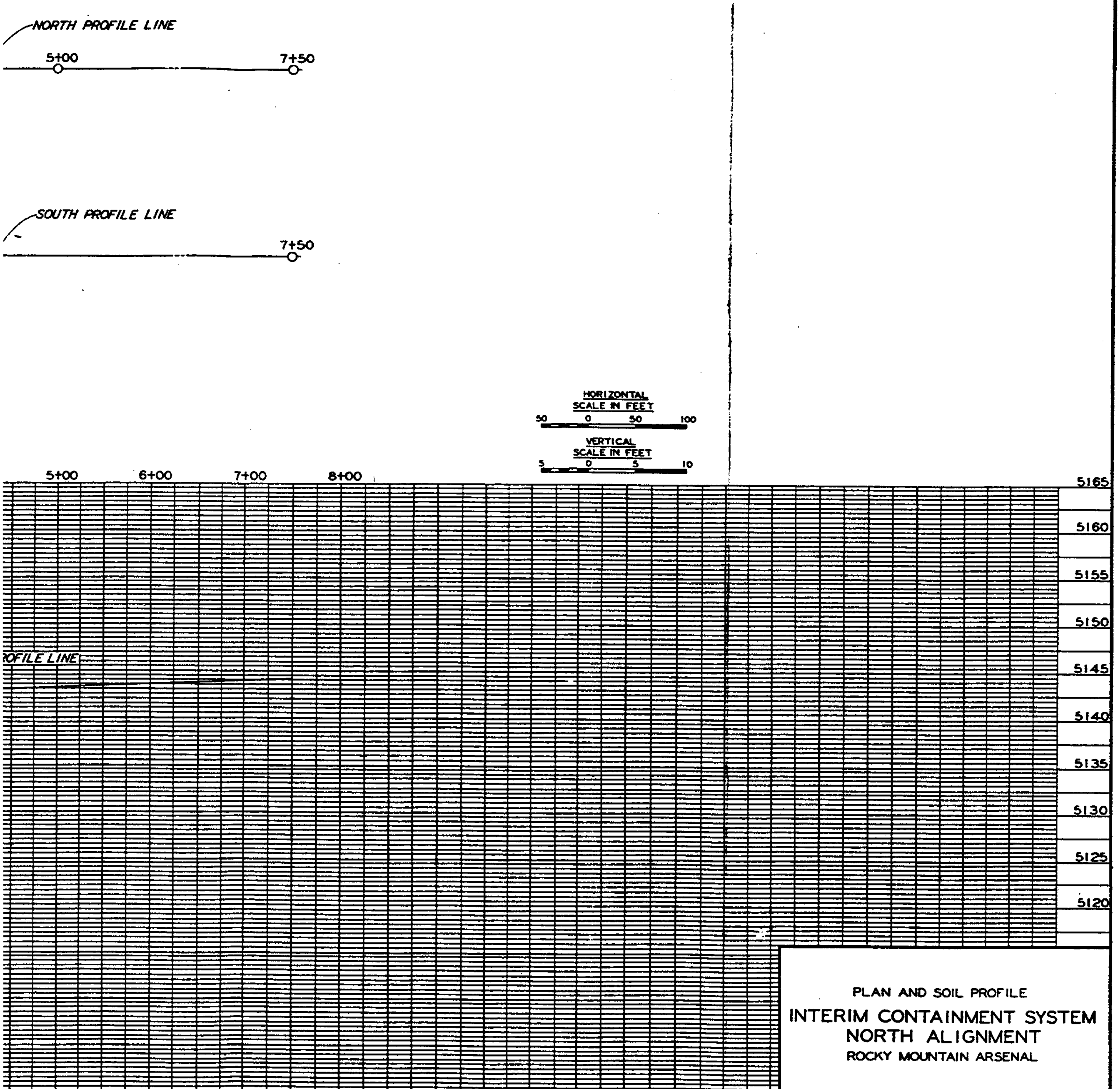
PLATE 2



N
60°
40+00 BK=
0+00 AH
UD-6
191
2+50
5+00
7+50
NORTH PROFILE LINE
200'
SOUTH PROFILE LINE
38+84.5 BK=
1+15.5 AH
2+50
A-8
198A
7+50
MATCH LINE
SEE PLATE 2



40+00 BK=
0+00 AH
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
NORTH PROFILE LINE
BORING
UD-6
CL
SC
SP
CL-SM
BEDROCK
(UNWEATHERED)

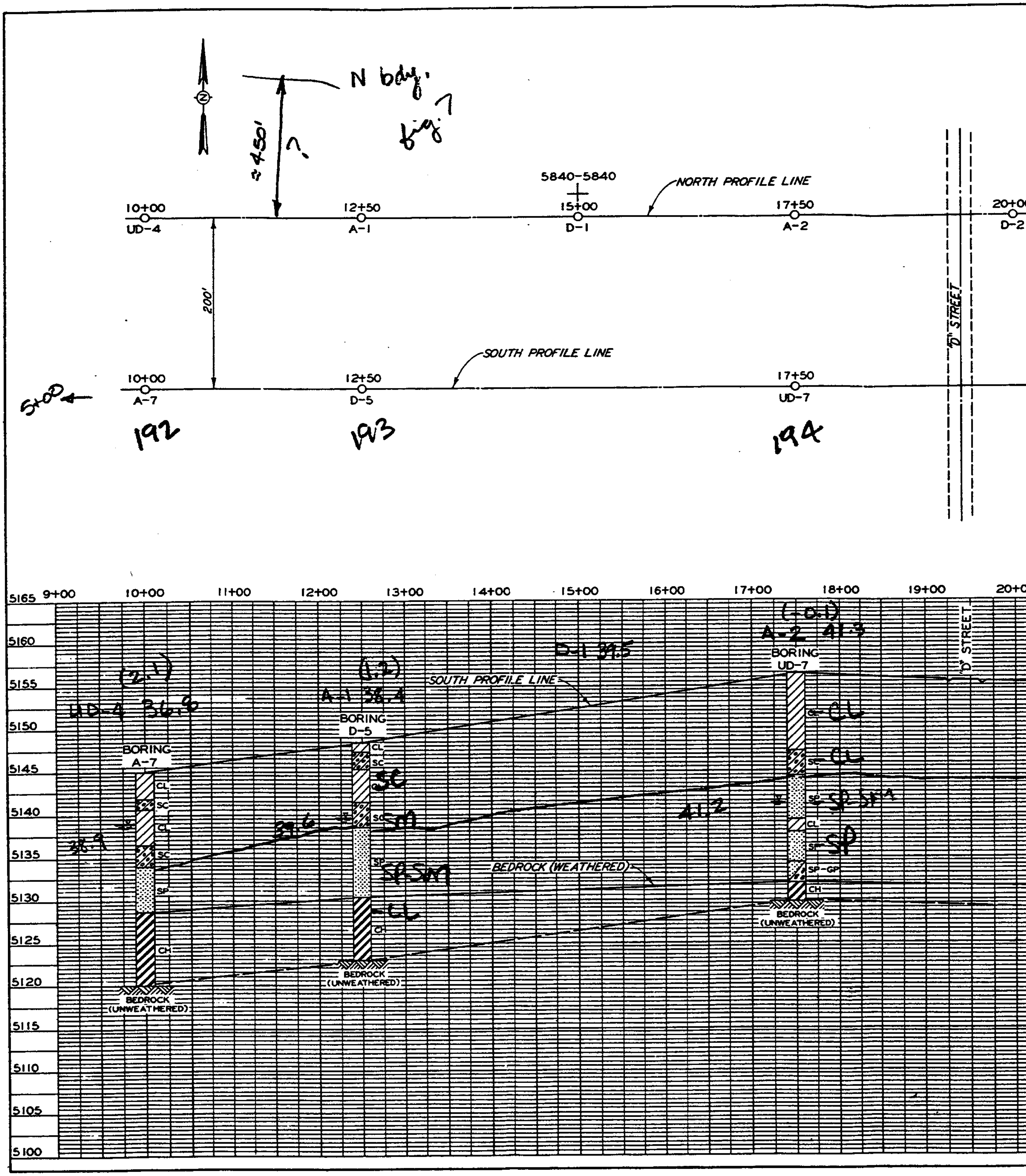


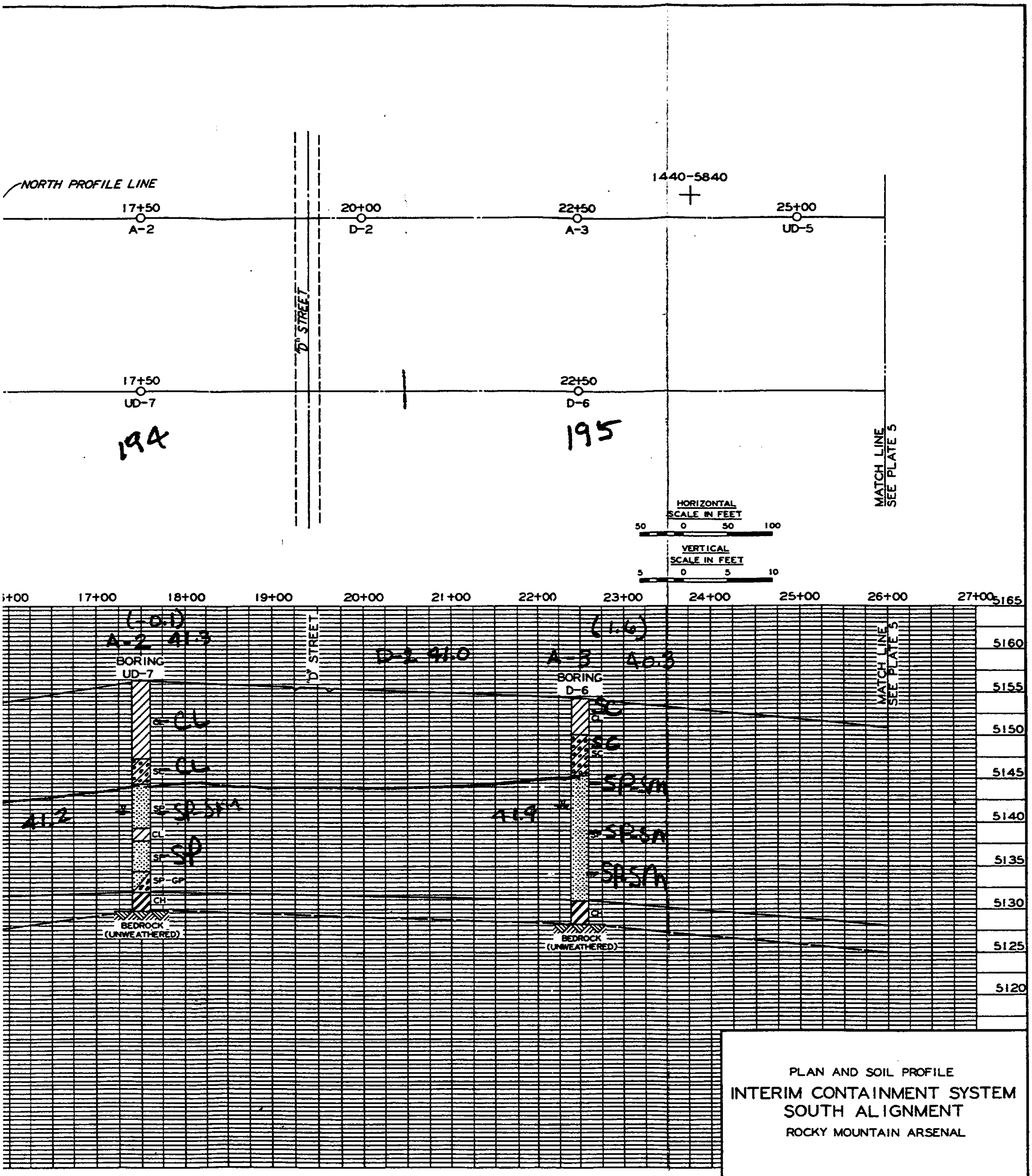
PLAN AND SOIL PROFILE

INTERIM CONTAINMENT SYSTEM
NORTH ALIGNMENT

ROCKY MOUNTAIN ARSENAL

PLATE 3


N bdy.
fig. 7
≈ 450'
5840-5840
NORTH PROFILE LINE
10+00
UD-4
12+50
A-1
15+00
D-1
17+50
A-2
20+00
D-2
200'
"D" STREET
SOUTH PROFILE LINE
10+00
A-7
12+50
D-5
17+50
UD-7
5+00
192
193
194
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
(-0.1)
A-2 41.3
D-1 39.5
(2.1)
UD-4 36.8
(1.2)
A-1 38.4
SOUTH PROFILE LINE
BORING
UD-7
BORING
D-5
BORING
A-7
CL
SC
SC
SM
SP
SP-SM
CH
CL
SP
SP-SM
SP
SP-GP
CH
41.2
39.6
38.9
BEDROCK (WEATHERED)
BEDROCK (UNWEATHERED)
BEDROCK (UNWEATHERED)
BEDROCK (UNWEATHERED)
"D" STREET

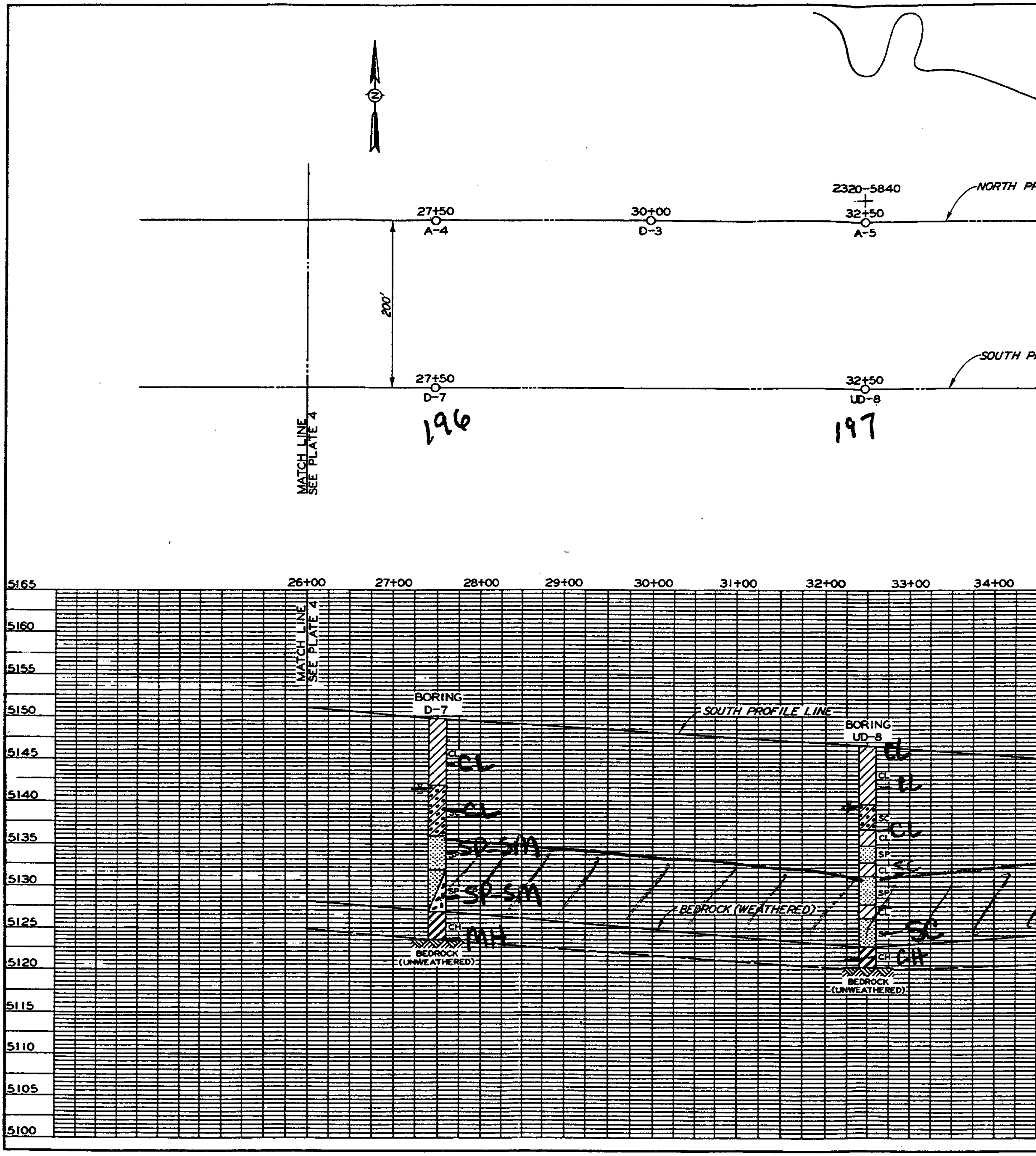


PLAN AND SOIL PROFILE

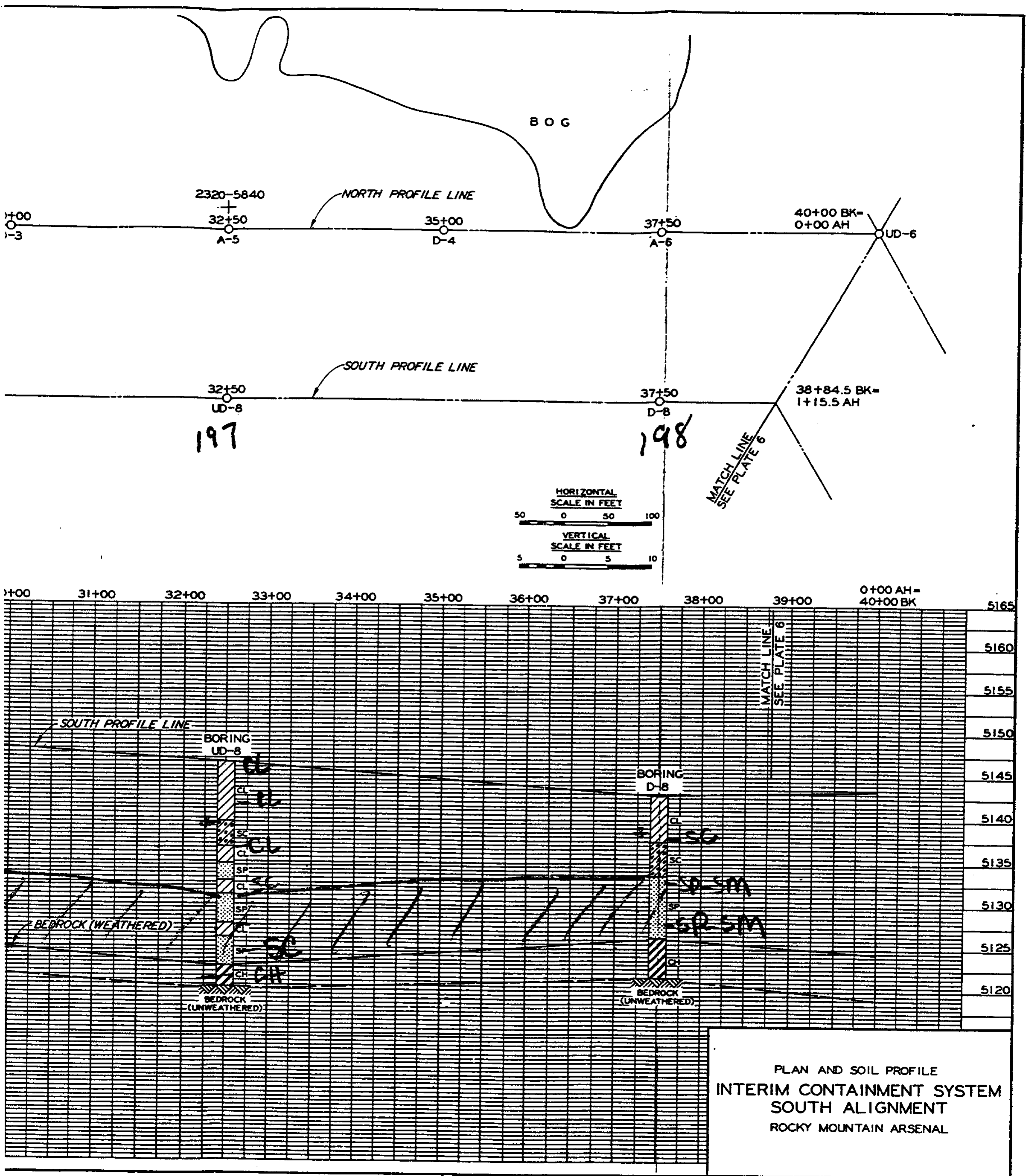
INTERIM CONTAINMENT SYSTEM SOUTH ALIGNMENT

ROCKY MOUNTAIN ARSENAL

PLATE 4

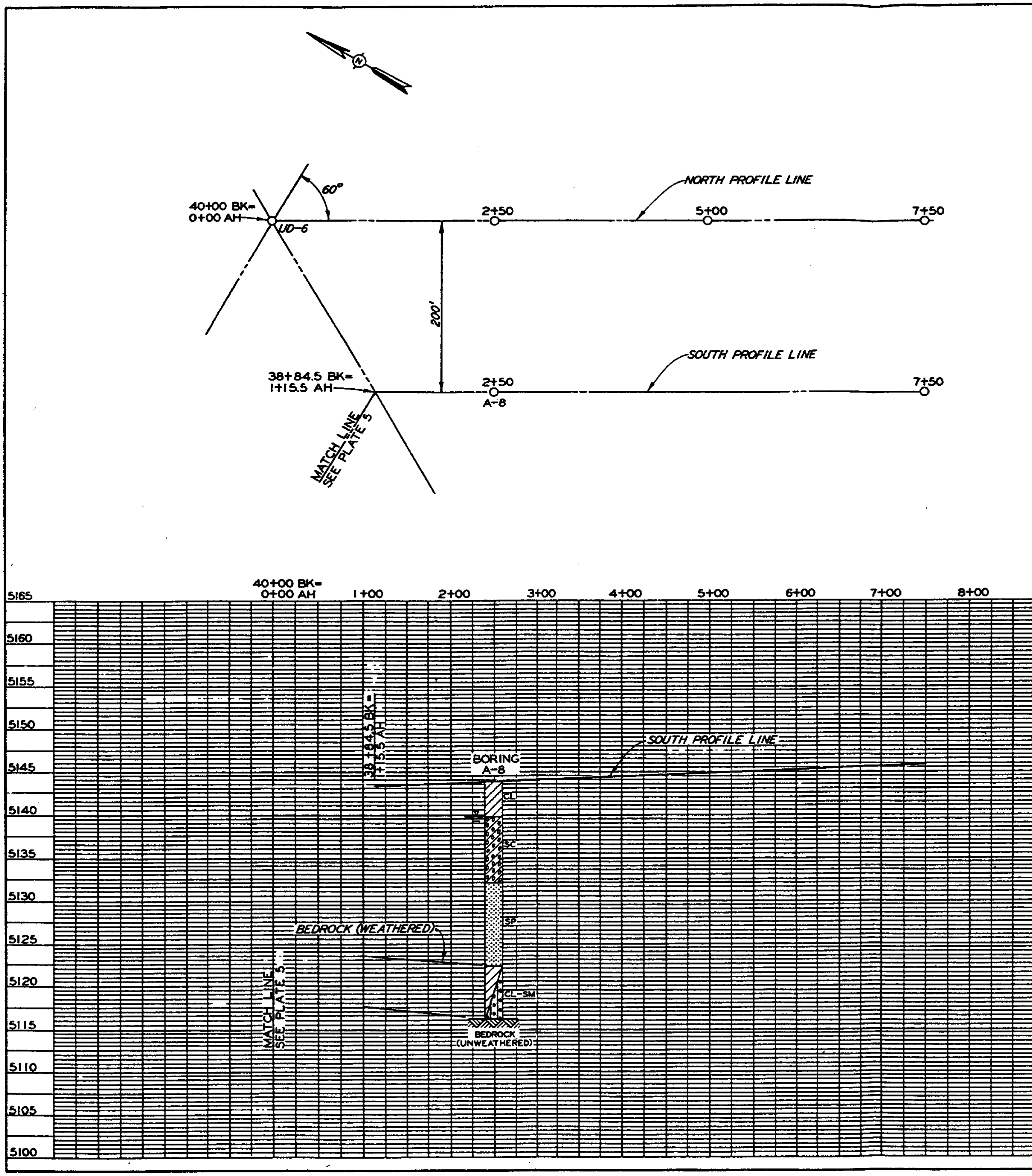


N
2320-5840
NORTH PR
27+50
A-4
30+00
D-3
32+50
A-5
200'
SOUTH PR
27+50
D-7
32+50
UD-8
196
197
MATCH LINE
SEE PLATE 4
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
26+00
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
MATCH LINE
SEE PLATE 4
BORING
D-7
SOUTH PROFILE LINE
BORING
UD-8
CL
CL
SP
SP
CH
CL
SP-SM
SP-SM
MH
BEDROCK
(UNWEATHERED)
BEDROCK (WEATHERED)
CL
CL
SC
CL
SP
CL
SP
CL
SP
CH
CL
CL
SC
SC
CH
BEDROCK
(UNWEATHERED)

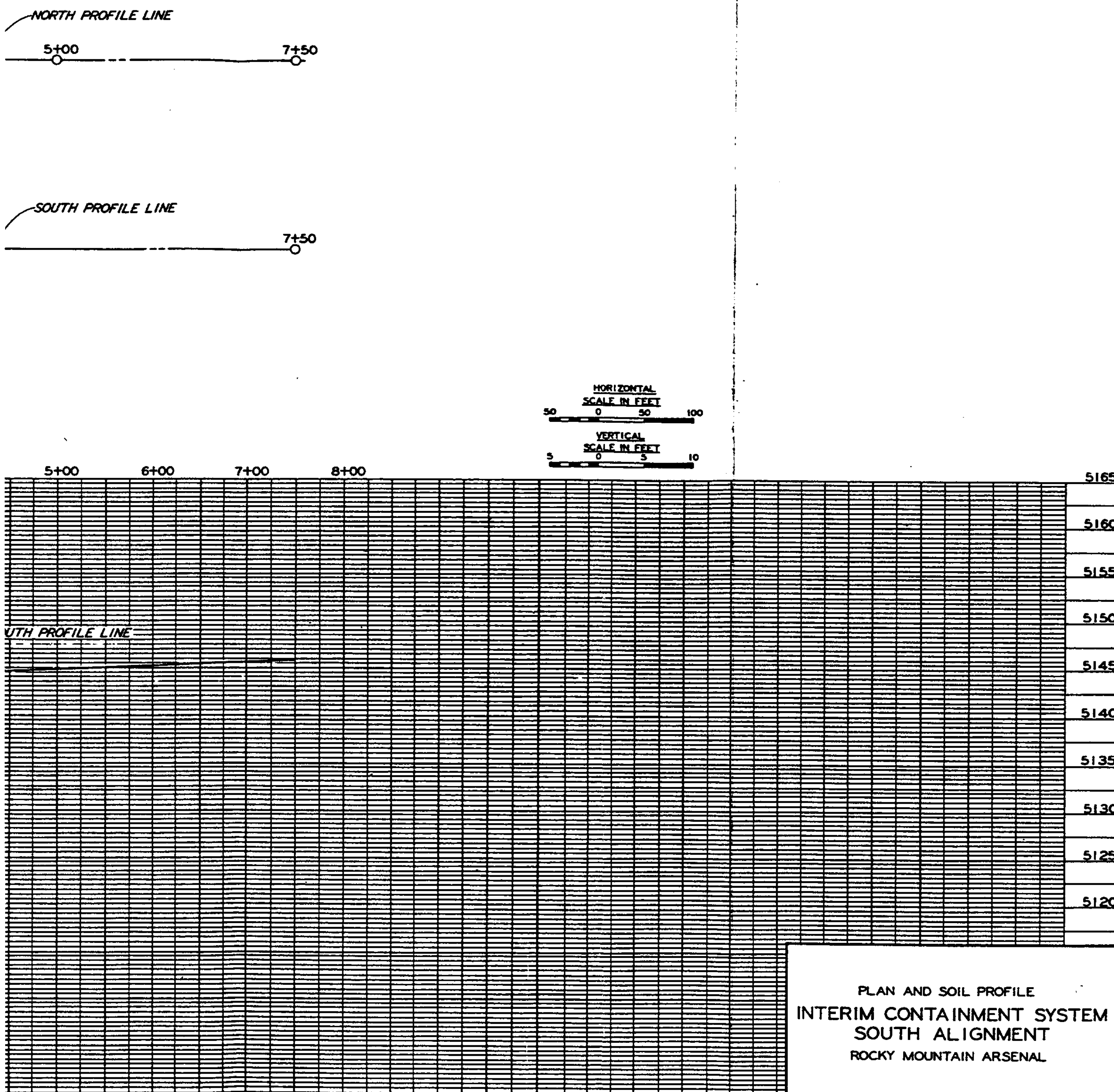


PLAN AND SOIL PROFILE
INTERIM CONTAINMENT SYSTEM
SOUTH ALIGNMENT
ROCKY MOUNTAIN ARSENAL

PLATE 5



NORTH PROFILE LINE
60°
40+00 BK=
0+00 AH
UD-6
2+50
5+00
7+50
200'
SOUTH PROFILE LINE
38+84.5 BK=
1+15.5 AH
2+50
A-8
7+50
MATCH LINE
SEE PLATE 5
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
40+00 BK=
0+00 AH
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
38+84.5 BK=
1+15.5 AH
SOUTH PROFILE LINE
BORING
A-8
CL
SC
SP
CL-SM
BEDROCK (WEATHERED)
BEDROCK
(UNWEATHERED)
MATCH LINE
SEE PLATE 5

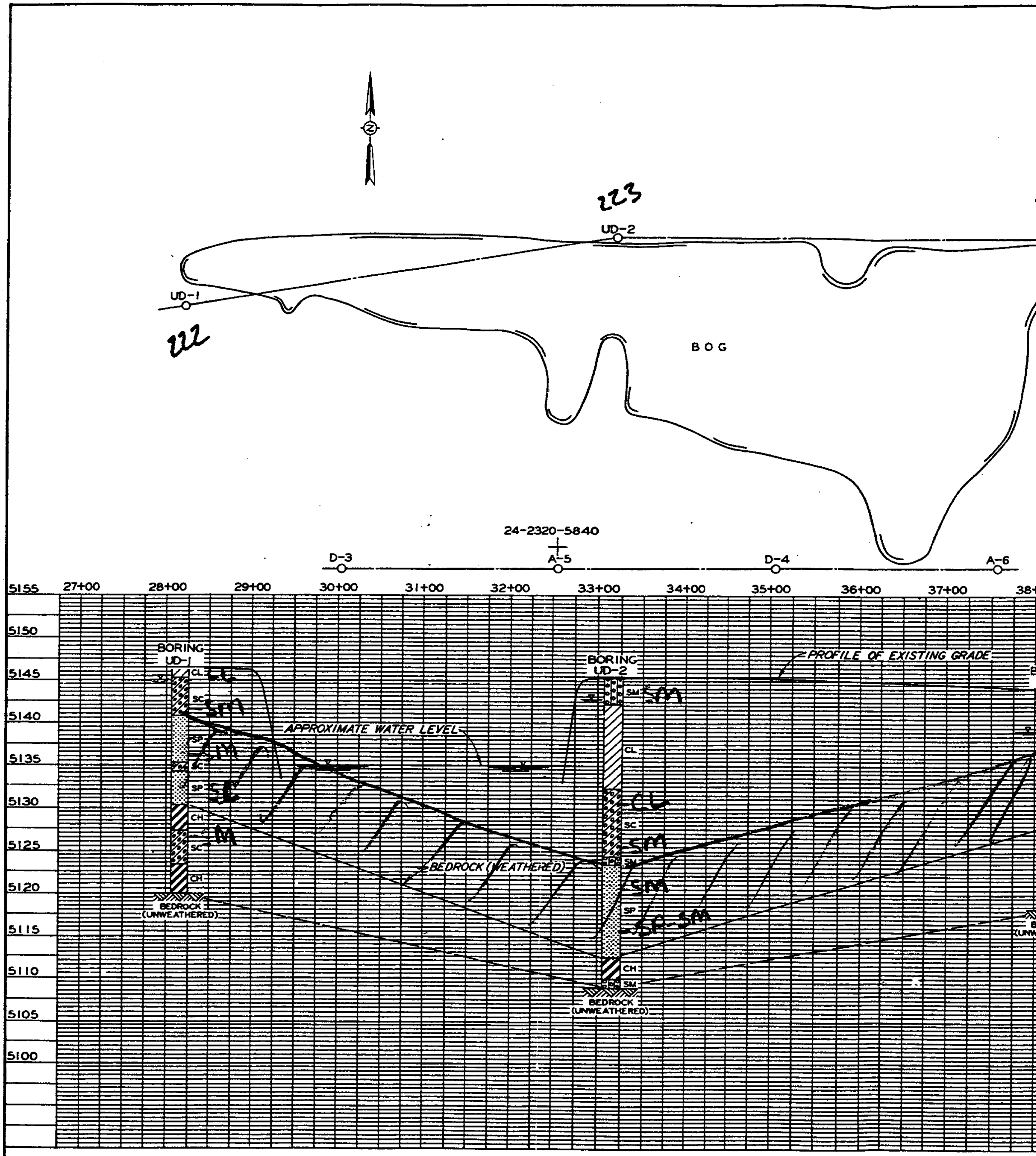


PLAN AND SOIL PROFILE

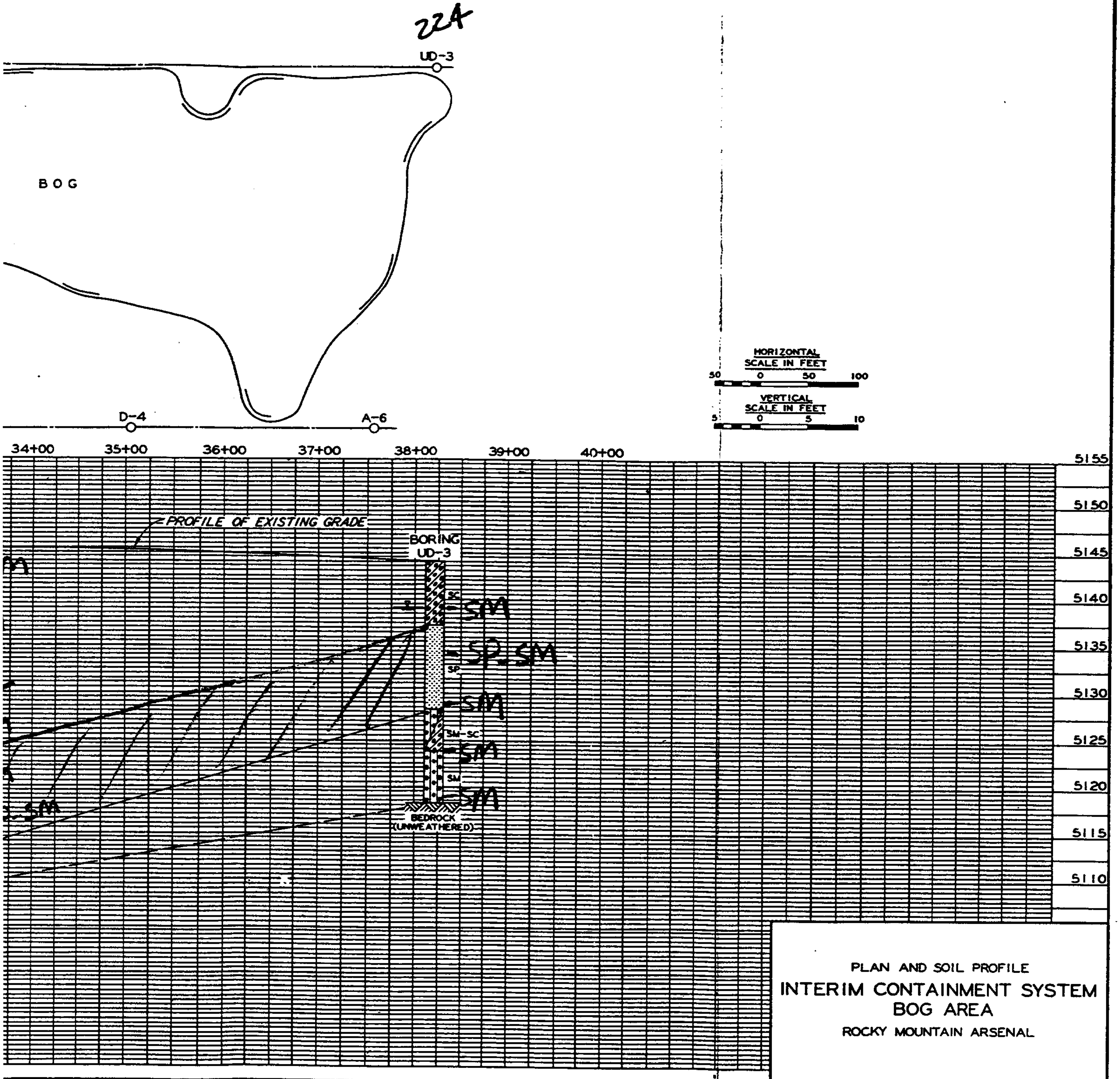
INTERIM CONTAINMENT SYSTEM
SOUTH ALIGNMENT

ROCKY MOUNTAIN ARSENAL

PLATE 6



223
UD-2
UD-1
222
BOG
24-2320-5840
D-3
A-5
D-4
A-6
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105
5100
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
BORING UD-1
BORING UD-2
PROFILE OF EXISTING GRADE
APPROXIMATE WATER LEVEL
BEDROCK (WEATHERED)
BEDROCK (UNWEATHERED)
CL
SC
SP
CH
SM
SM
CL
SC
SM
SA-SM



PLAN AND SOIL PROFILE

INTERIM CONTAINMENT SYSTEM
BOG AREA

ROCKY MOUNTAIN ARSENAL

PLATE 7

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		TYPE	LETTER SYMBOL	SYMBOL	TYPICAL NAMES
COARSE - GRAINED SOILS More than half of material is larger than No 200 sieve size.	GRAVELS More than half of coarse fraction is larger than No 4 sieve size.	CLEAN GRAVEL (Little or No Fines)	GW		GRAVEL, Well Graded, gravel-sand mixtures, little or no fines
			GP		GRAVEL, Poorly Graded, gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable Amount of Fines)	GM		SILTY GRAVEL, gravel-sand-silt mixtures
			GC		CLAYEY GRAVEL, gravel-sand-clay mixtures
	SANDS More than half of coarse fraction is smaller than No.4 sieve size.	CLEAN SAND (Little or No Fines)	SW		SAND, Well-Graded, gravelly sands
			SP		SAND, Poorly-Graded, gravelly sands
		SANDS WITH FINES (Appreciable Amount of Fines)	SM		SILTY SAND, sand-silt mixtures
			SC		CLAYEY SAND, sand-clay mixtures
FINE - GRAINED SOILS More than half the material is smaller than No. 200 sieve size		SILTS AND CLAYS (Liquid Limit <50)	ML		SILT & very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
			CL		LEAN CLAY; Sandy Clay; Silty Clay; of low to medium plasticity
			OL		ORGANIC SILTS and organic silty clays of low plasticity
		SILTS AND CLAYS (Liquid Limit >50)	MH		SILT, fine sandy or silty soil with high plasticity
			CH		FAT CLAY, inorganic clay of high plasticity
			OH		ORGANIC CLAYS of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt		PEAT, and other highly organic soil
WOOD			Wd		WOOD
SHELLS			Sl		SHELLS
NO SAMPLE					

NOTE: Soils possessing characteristics of two groups are designated by combinations of group symbols

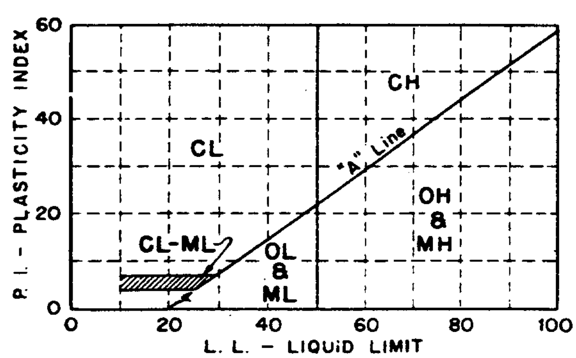
DESCRIPTIVE SYMBOLS

COLOR

COLOR	SYMBOL
TAN	T
YELLOW	Y
RED	R
BLACK	BK
GRAY	Gr
LIGHT GRAY	lGr
DARK GRAY	dGr
BROWN	Br
LIGHT BROWN	lBr
DARK BROWN	dBr
BROWNISH-GRAY	br Gr
GRAYISH-BROWN	gyBr
GREENISH-GRAY	gnGr
GRAYISH-GREEN	gyGn
GREEN	Gn
BLUE	Bl
BLUE-GREEN	BlGn
WHITE	Wh
MOTTLED	Mot

CONSISTENCY FOR COHESIVE SOILS

CONSISTENCY	COHESION IN LBS./SQ.FT. FROM UNCONFINED COMPRESSION TEST	SYMBOL
VERY SOFT	< 250	vSo
SOFT	250 - 500	So
MEDIUM	500 - 1000	M
STIFF	1000 - 2000	St
VERY STIFF	2000 - 4000	vSt
HARD	> 4000	H



PLASTICITY CHART

For classification of fine - grained soils

MODIFICATIONS

MODIFICATION	SYMBOL
Traces	Tr-
Fine	F
Medium	M
Coarse	C
Concretions	cc
Rootlets	rt
Lignite fragments	lg
Shale fragments	sh
Sandstone fragments	sds
Shell fragments	slf
Organic matter	O
Clay strata or lenses	CS
Silt strata or lenses	SIS
Sand strata or lenses	SS
Sandy	S
Gravelly	G
Boulders	B
Slickensides	SL
Wood	Wd
Oxidized	Ox
Crumbly	Cr
Loose	Lo
Vegetation	Veg

ith slight plasticity
city

symbols

ATIONS	
ION	SYMBOL
	Tr-
	F
	M
	C
	cc
	rt
nts	lg
nts	sh
nents	sds
ts	slf
	O
enses	CS
enses	SIS
enses	SS
	S
	G
	B
	SL
	Wd
	Ox
	Cr
	Lo
	Veg

NOTES:
FIGURES TO LEFT OF BORING UNDER COLUMN "W OR D_{10}"
Are natural water contents in percent dry weight
When underlined denotes D_{10} size in mm *
FIGURES TO LEFT OF BORING UNDER COLUMNS "LL" AND "PL"
Are liquid and plastic limits, respectively
SYMBOLS TO LEFT OF BORING
▽ Ground-water surface and date observed
(C) Denotes location of consolidation test **
(S) Denotes location of consolidated-drained direct shear test **
(R) Denotes location of consolidated-undrained triaxial compression test **
(O) Denotes location of unconsolidated-undrained triaxial compression test **
(T) Denotes location of sample subjected to consolidation test and each of the above three types of shear tests **
FW Denotes free water
FIGURES TO RIGHT OF BORING
Are values of cohesion in lbs./sq. ft. from unconfined compression tests
In parenthesis are driving resistances in blows per foot determined with a standard split spoon sampler ($1\frac{3}{8}$" I.D., 2" O.D.) and a 140 lb. driving hammer with a 30" drop
Where underlined with a solid line denotes laboratory permeability in centimeters per second of undisturbed sample
Where underlined with a dashed line denotes laboratory permeability in centimeters per second of sample remoulded to the estimated natural void ratio

* The D_{10} size of a soil is the grain diameter in millimeters of which 10% of the soil is finer, and 90% coarser than size D_{10}.

**Results of these tests are available for inspection in the U.S. Army Engineer District Office, if these symbols appear beside the boring logs on the drawings.

GENERAL NOTES:

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and, if encountered, such variations will not be considered as differing materially within the purview of clause 4 of the contract.

Ground-water elevations shown on the boring logs represent ground-water surfaces encountered on the dates shown. Absence of water surface data on certain borings implies that no ground-water data is available, but does not necessarily mean that ground water will not be encountered at the locations or within the vertical reaches of these borings.

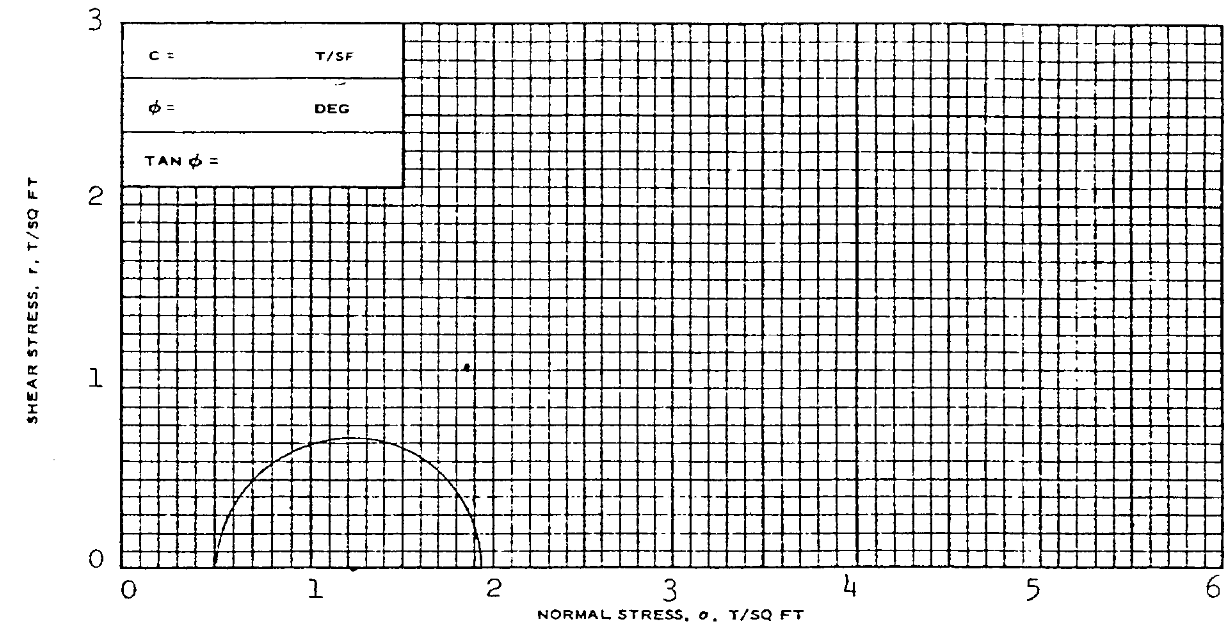
Consistency of cohesive soils shown on the boring logs is based on driller's log and visual examination and is approximate, except within those vertical reaches of the borings where shear strengths from unconfined compression tests are shown.

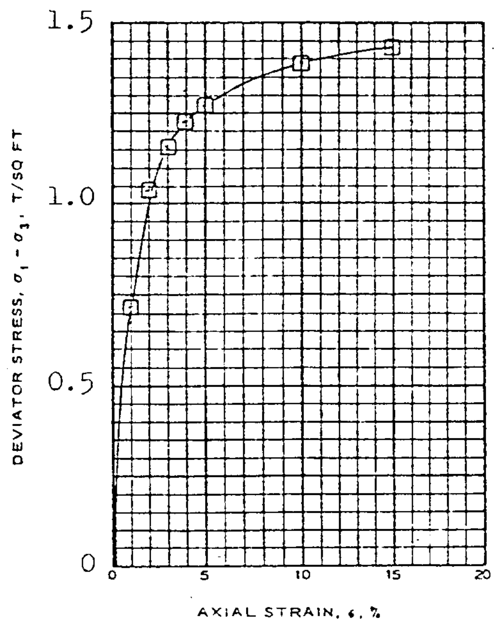
SOIL BORING LEGEND

Table 1

Purpose of Groundwater Observation Wells

Well Number - Figure 7	Purpose
1, 3, 8, 16, 23, 27, 9, 17	Indicate incoming groundwater quality and quantity
4, 9, 17, 24, 10, 18	Indicate groundwater levels around dewatering system used to establish pumping rates
1, 2, 27, 28	Indicate influence of interim containment system on groundwater outside of the local area of the system
10, 18, 11, 15, 19	Indicate groundwater levels on each side of barrier and effectiveness of barrier
wells north of bog	Indicate recharge rate and effect of recharge on water quality
north-south lines of wells	Readings for groundwater level cross sections
all wells	Readings used for groundwater level and quality contour maps





SPECIMEN NO.			1			
INITIAL	WATER CONTENT, %	w_o	19.1			
	DRY DENSITY LB/CU FT	γd_o	99.4			
	SATURATION, %	S_o	58.8			
	VOID RATIO	e_o	0.877			
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5			
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.43			
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	37			
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40			
INITIAL HEIGHT, IN.		H_o	3.00			

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS LEAN CLAY(CL),brown;with fine sand

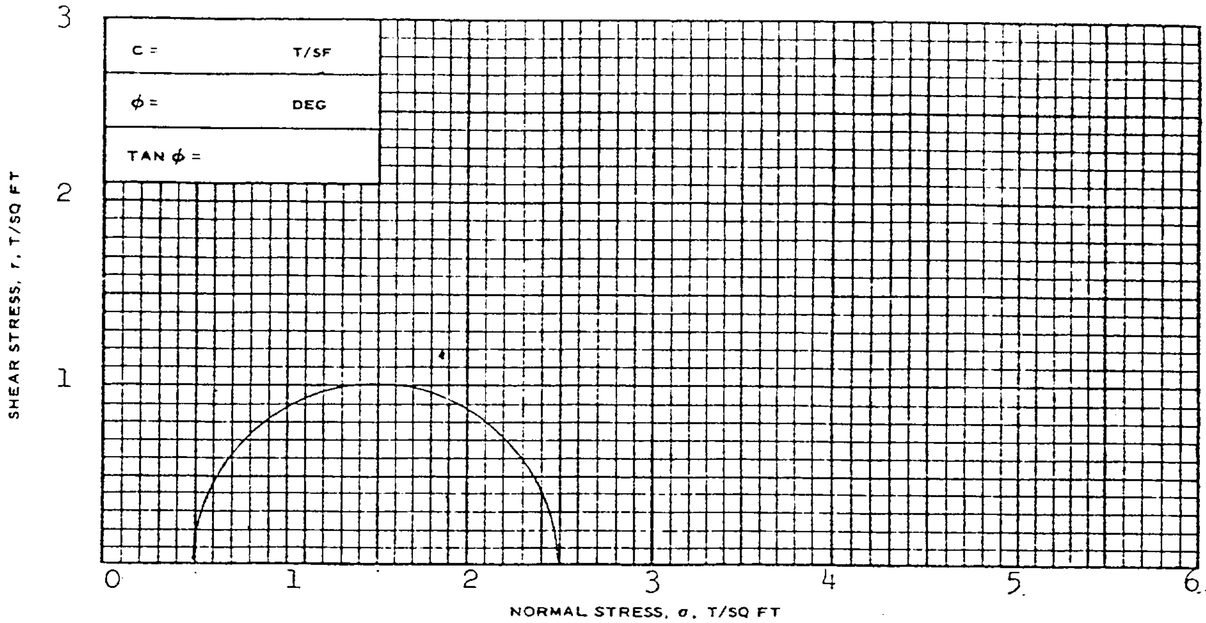
LL 36	PL 16	PI 20	Gs 2.70	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

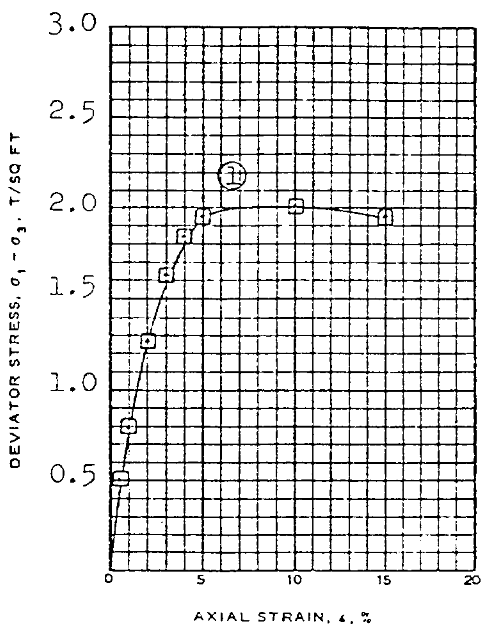
REMARKS: Soil too friable to permit trimming more specimens.

PROJECT ROCKY MOUNTAIN ARSENAL

BORING NO.	UD-2	SAMPLE NO.	2
DEPTH/ELEV			
LABORATORY	USAEWES	DATE	1 Sept., 1976

KOC TRIAXIAL COMPRESSION TEST REPORT





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	14.5	11.4		
	DRY DENSITY LB/CU FT	γd_o	100.3	116.7		
	SATURATION, %	S_o	56.9	68.1		
	VOID RATIO	e_o	0.693	0.455		
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.5		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	2.00	8.8+		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	21			
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40	1.41		
INITIAL HEIGHT, IN.		H_o	3.00	3.00		

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY CLAY(CL), brown

LL 29 | PL 14 | PI 15 | Gs 2.72 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Specimen 2 exceeded capacity of testing machine without failing. Insufficient sample for trimming additional specimens.

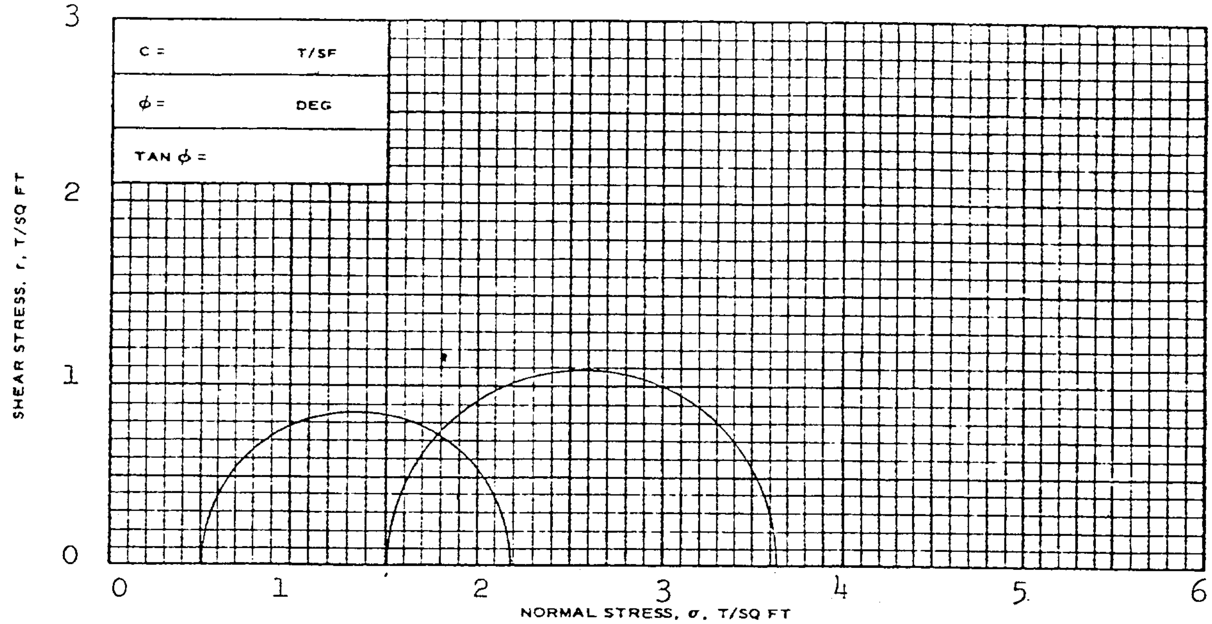
PROJECT ROCKY MOUNTAIN ARSENAL

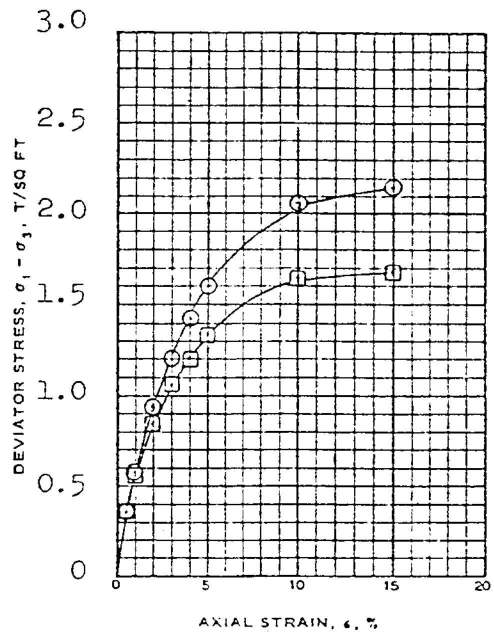
BORING NO. UD-3 | SAMPLE NO. 1

DEPTH/ELEV

LABORATORY USAEWES | DATE 13 Sept., 1976

KOC TRIAXIAL COMPRESSION TEST REPORT





SPECIMEN NO.			1	2		
INITIAL	WATER CONTENT, %	w_o	15.5	15.9		
	DRY DENSITY LB/CU FT	γd_o	114.0	110.0		
	SATURATION, %	S_o	88.2	81.2		
	VOID RATIO	e_o	0.473	0.527		
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.5		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.68	2.13		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	32	32		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40	1.40		
INITIAL HEIGHT, IN.		H_o	3.00	3.00		

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY SILT(ML), brown

LL 20 | PL 17 | PI 3 | Gs 2.69 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Soil too friable to permit trimming more test specimens.

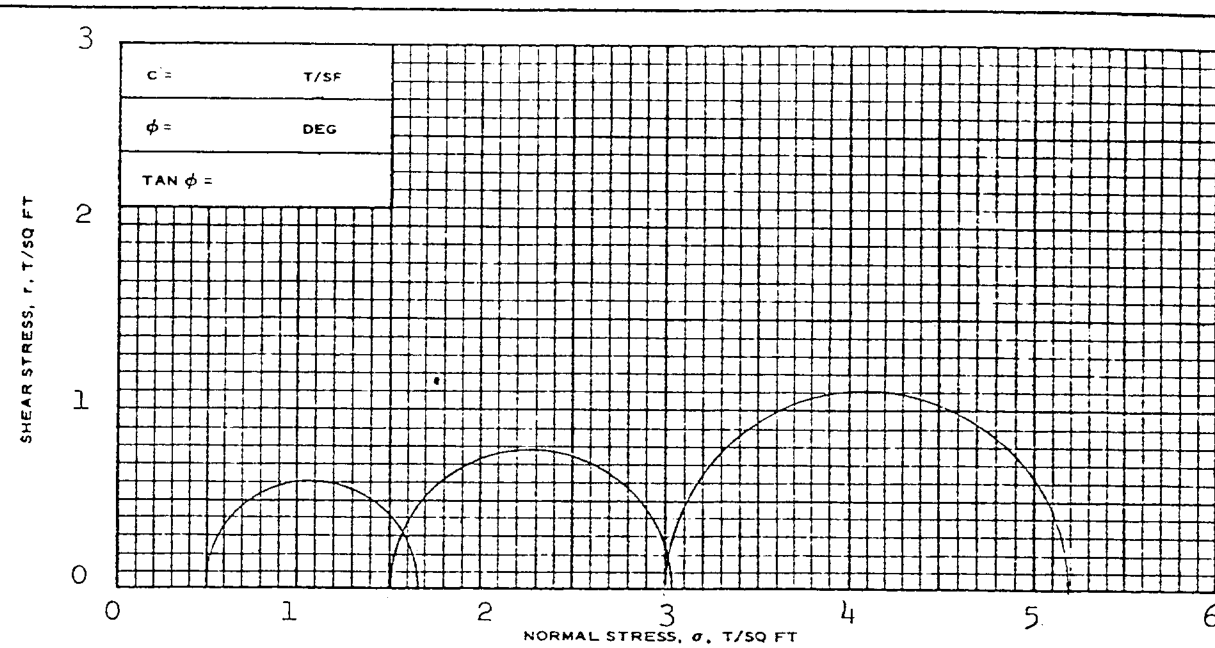
PROJECT ROCKY MOUNTAIN ARSENAL

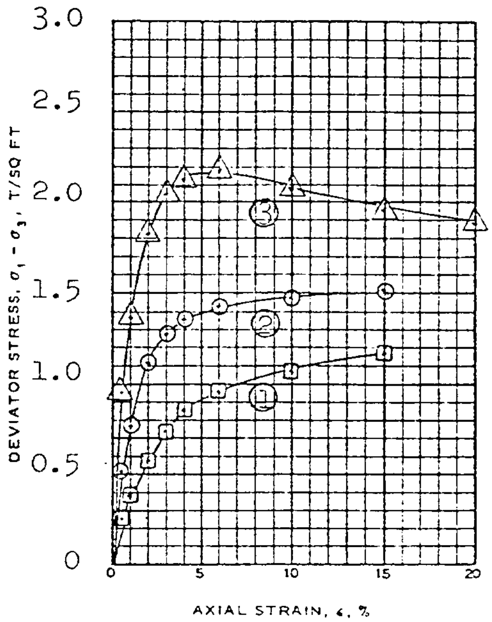
BORING NO. UD-3 | SAMPLE NO. 2

DEPTH/ELEV

LABORATORY USAEWES | DATE 14 Sept., 1976

KOC TRIAXIAL COMPRESSION TEST REPORT





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	18.7	18.0	18.9	
	DRY DENSITY LB/CU FT	γd_o	102.7	101.2	95.3	
	SATURATION, %	S_o	78.3	72.6	66.1	
	VOID RATIO	e_o	0.647	0.672	0.775	
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.5	3.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.17	1.51	2.19	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	30	32	20	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40	1.41	1.39	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00	

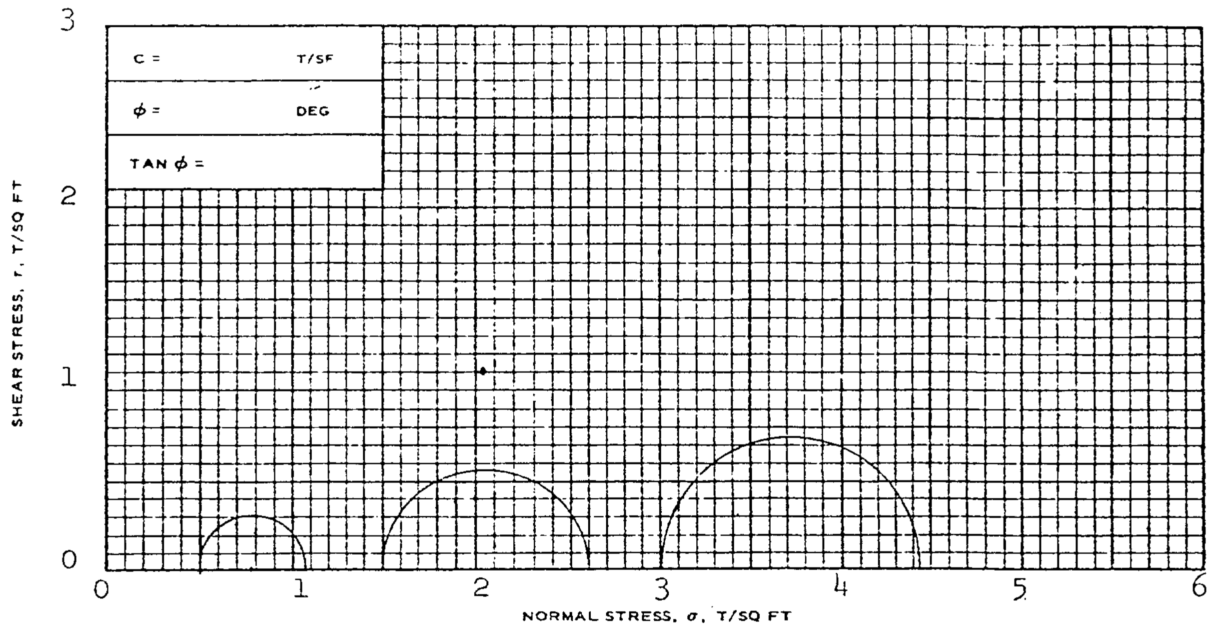
CONTROLLED- STRAIN TEST

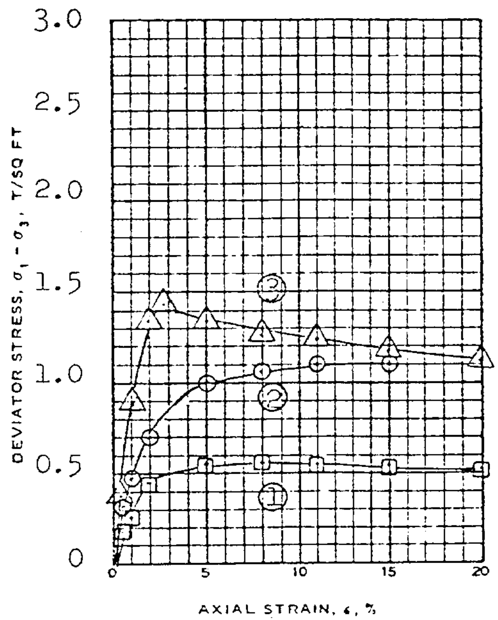
DESCRIPTION OF SPECIMENS SANDY, SILTY CLAY(CL), yellow

LL 39	PL 23	PI 16	Gs 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS:	PROJECT ROCKY MOUNTAIN ARSENAL	
	BORING NO. UD-4	SAMPLE NO. 2
	DEPTH/ELEV 5.0-7.0	
	LABORATORY USAEWES	DATE 16 August, 1976
	TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089
REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	22.0	23.7	24.3	
	DRY DENSITY LB/CU FT	γd_o	88.2	98.4	95.6	
	SATURATION, %	S_o	65.5	90.2	86.4	
	VOID RATIO	e_o	0.904	0.707	0.757	
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.5	3.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.56	1.10	1.42	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	13	20	7	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.43	1.39	1.43	
INITIAL HEIGHT, IN.		H_o				

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY CLAY(CL), brown

LL 34	PL 15	PI 19	Gs 2.69	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS:

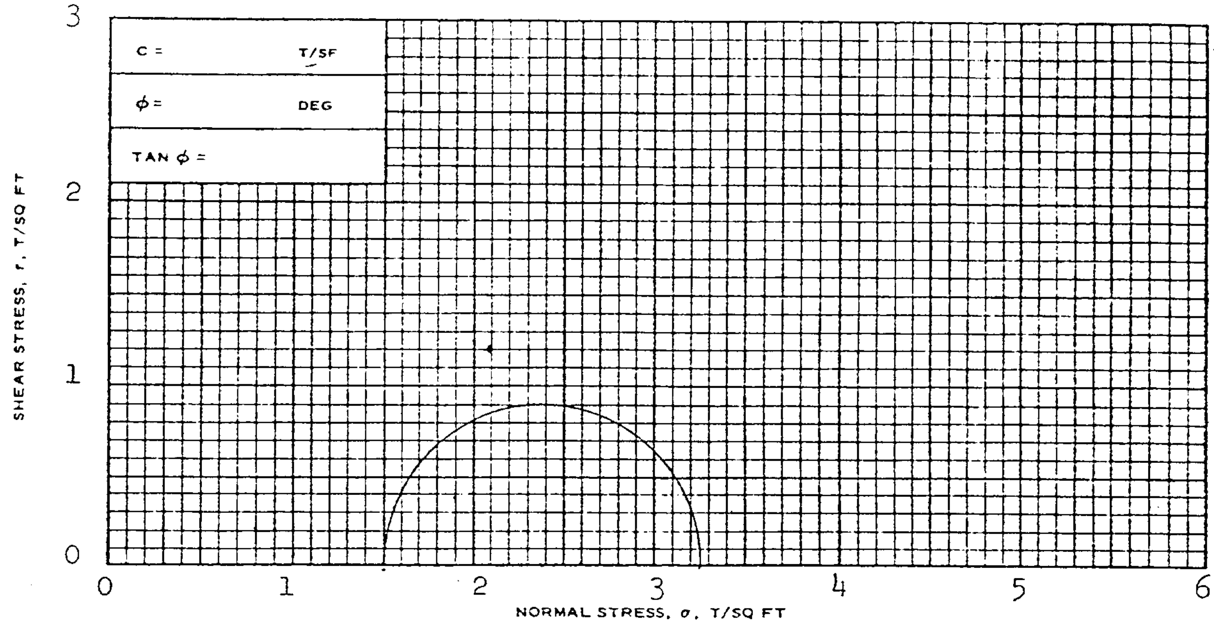
PROJECT ROCKY MOUNTAIN ARSENAL

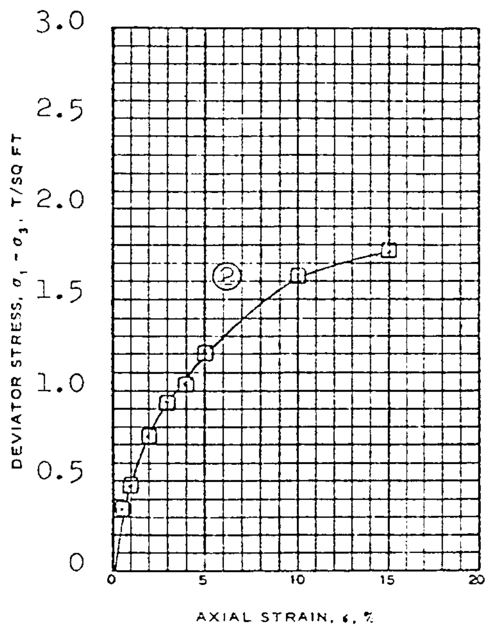
BORING NO. UD-5 SAMPLE NO. 2

DEPTH/ELEV 5.0-7.5

LABORATORY USAEWES DATE 16 August, 1976

JMS TRIAXIAL COMPRESSION TEST REPORT





SPECIMEN NO.				2		
INITIAL	WATER CONTENT, %	w_o		17.0		
	DRY DENSITY LB/CU FT	γd_o		79.1		
	SATURATION, %	S_o		40.6		
	VOID RATIO	e_o		1.13		
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3		1.5		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$		1.76		
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f		36		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o		1.38		
INITIAL HEIGHT, IN.		H_o		3.00		

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY CLAY(CL), light brown

LL 29	PL 14	PI 15	Gs 2.70	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Soil too friable to permit trimming more specimens.

PROJECT ROCKY MOUNTAIN ARSENAL

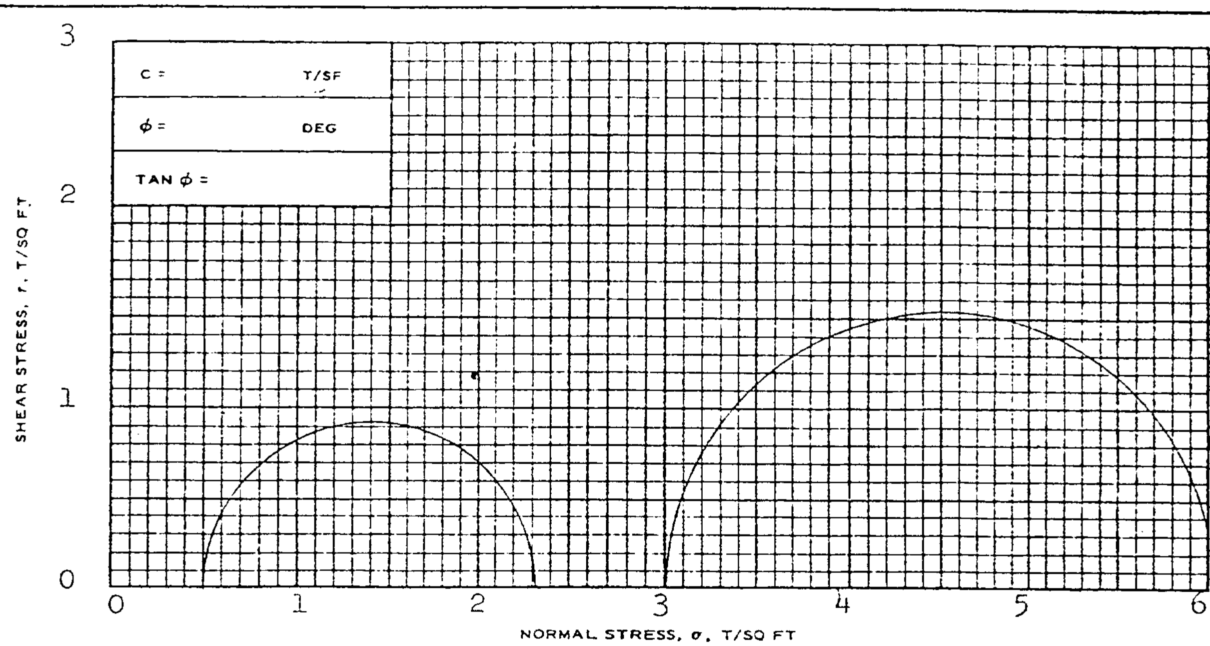
BORING NO. UD-7 SAMPLE NO. 3

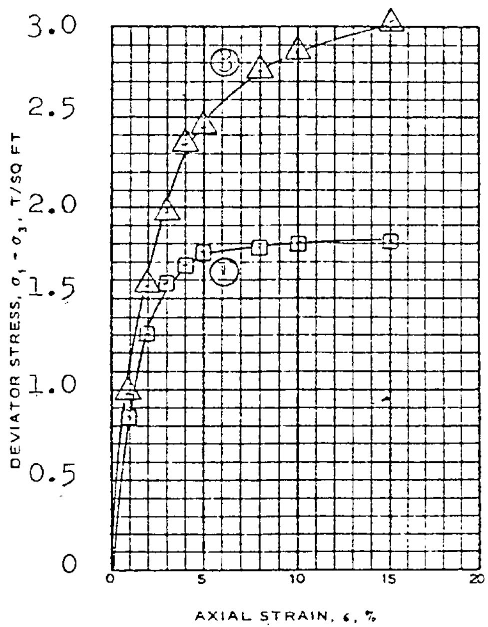
DEPTH/ELEVm 10.0-12.5

LABORATORY USAEWES DATE 13 August,1976

KOC TRIAXIAL COMPRESSION TEST REPORT

C =	T/SF
ϕ =	DEG
TAN ϕ =	





SPECIMEN NO.			1		3	
INITIAL	WATER CONTENT, %	w_o	18.7		19.2	
	DRY DENSITY LB/CU FT	γd_o	102.3		101.7	
	SATURATION, %	S_o	76.2		77.1	
	VOID RATIO	e_o	0.672		0.682	
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5		3.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.81		3.02	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	35		35	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40		1.41	
INITIAL HEIGHT, IN.		H_o	3.00		3.00	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS LEAN CLAY(CL), brown, 1/8" diam. roots.

LL 42	PL 19	PI 23	Gs 2.74	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS:

PROJECT ROCKY MOUNTAIN ARSENAL

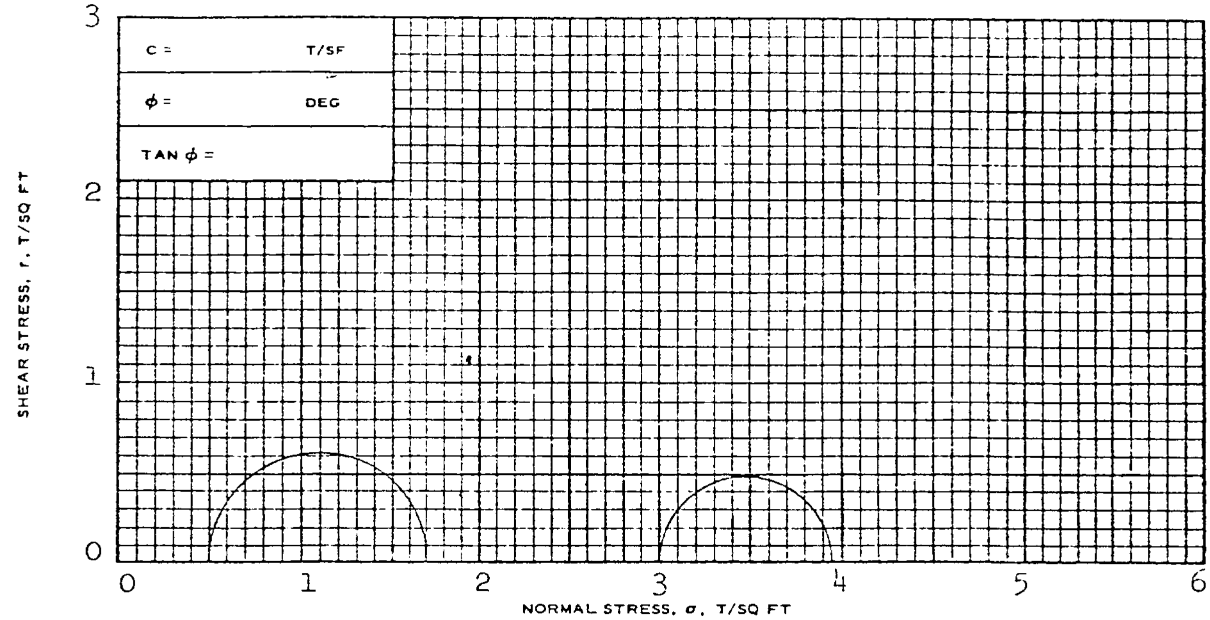
BORING NO. UD-8 SAMPLE NO. 1

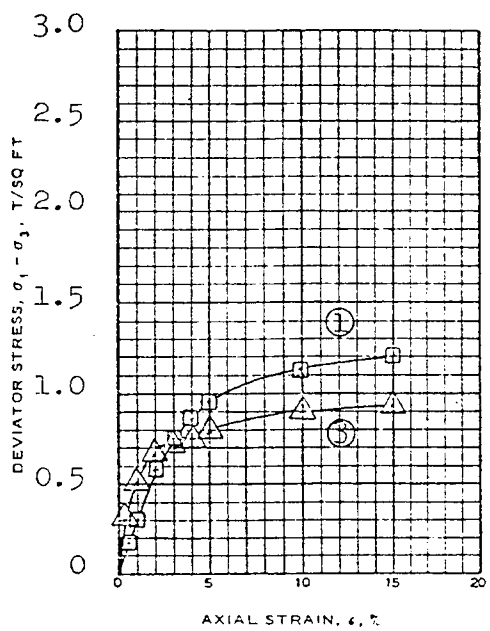
DEPTH/ELEV

LABORATORY USAEWES DATE 1 Sept., 1976

KOC TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)





SPECIMEN NO.			1		3	
INITIAL	WATER CONTENT, %	w_o	22.9		25.2	
	DRY DENSITY LB/CU FT	γd_o	103.6		96.0	
	SATURATION, %	S_o	98.6		90.1	
	VOID RATIO	e_o	0.627		0.755	
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5		3.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.20		0.94	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	34		38	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o	1.40		1.40	
INITIAL HEIGHT, IN.		H_o	3.00		3.00	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY CLAY(CL), brown

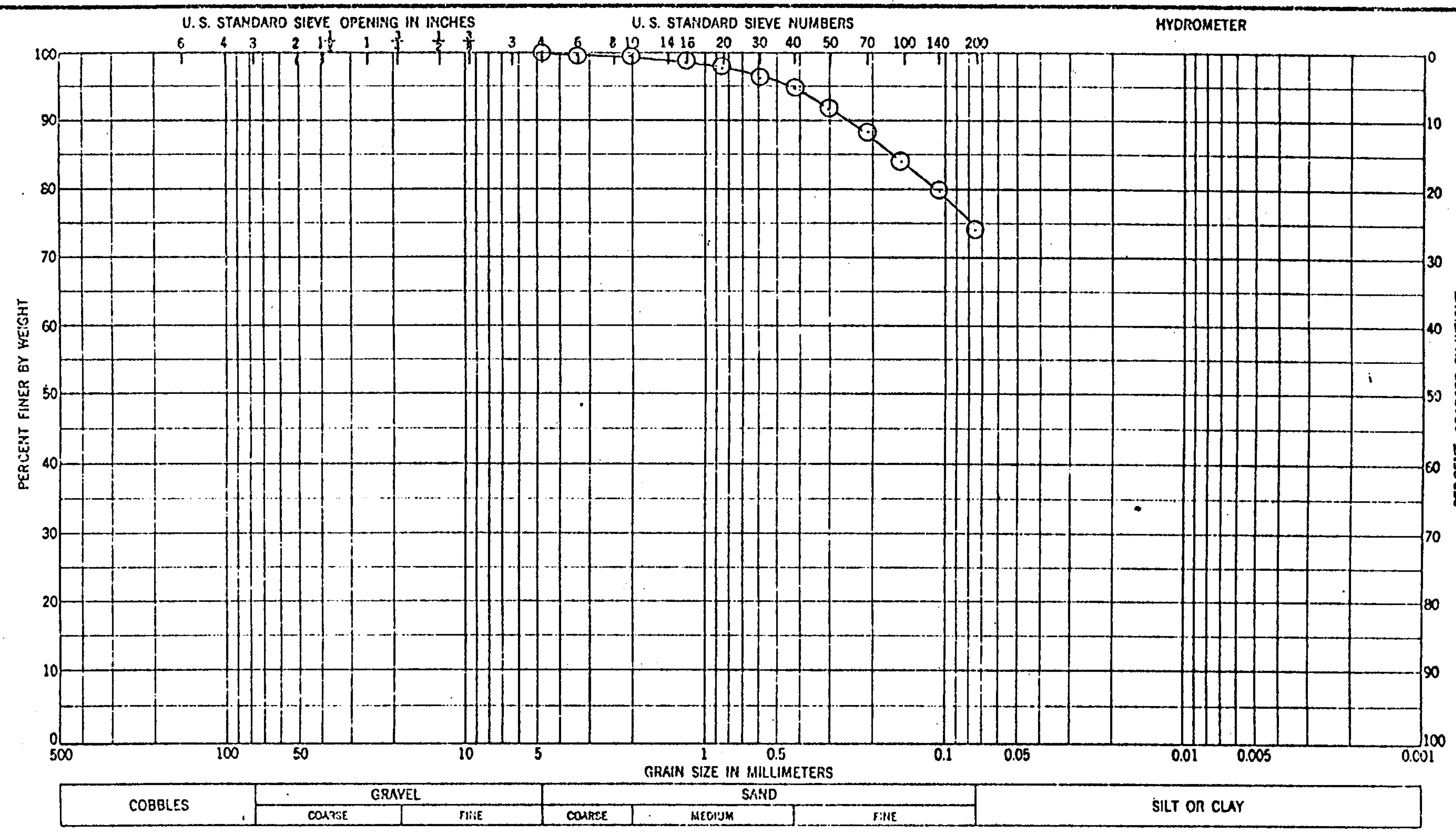
LL 34	PL 15	PI 19	Gs 2.70	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS:

PROJECT	ROCKY MOUNTAIN ARSENAL		
BORING NO.	UD-8	SAMPLE NO.	3
DEPTH/ELEV			
LABORATORY	USAEWES	DATE	13 Sept., 1976

KOC TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	0.0-1.5	SANDY CLAY(CL)	10.4	36	17	17
		Brown				
		Gs= 2.67(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

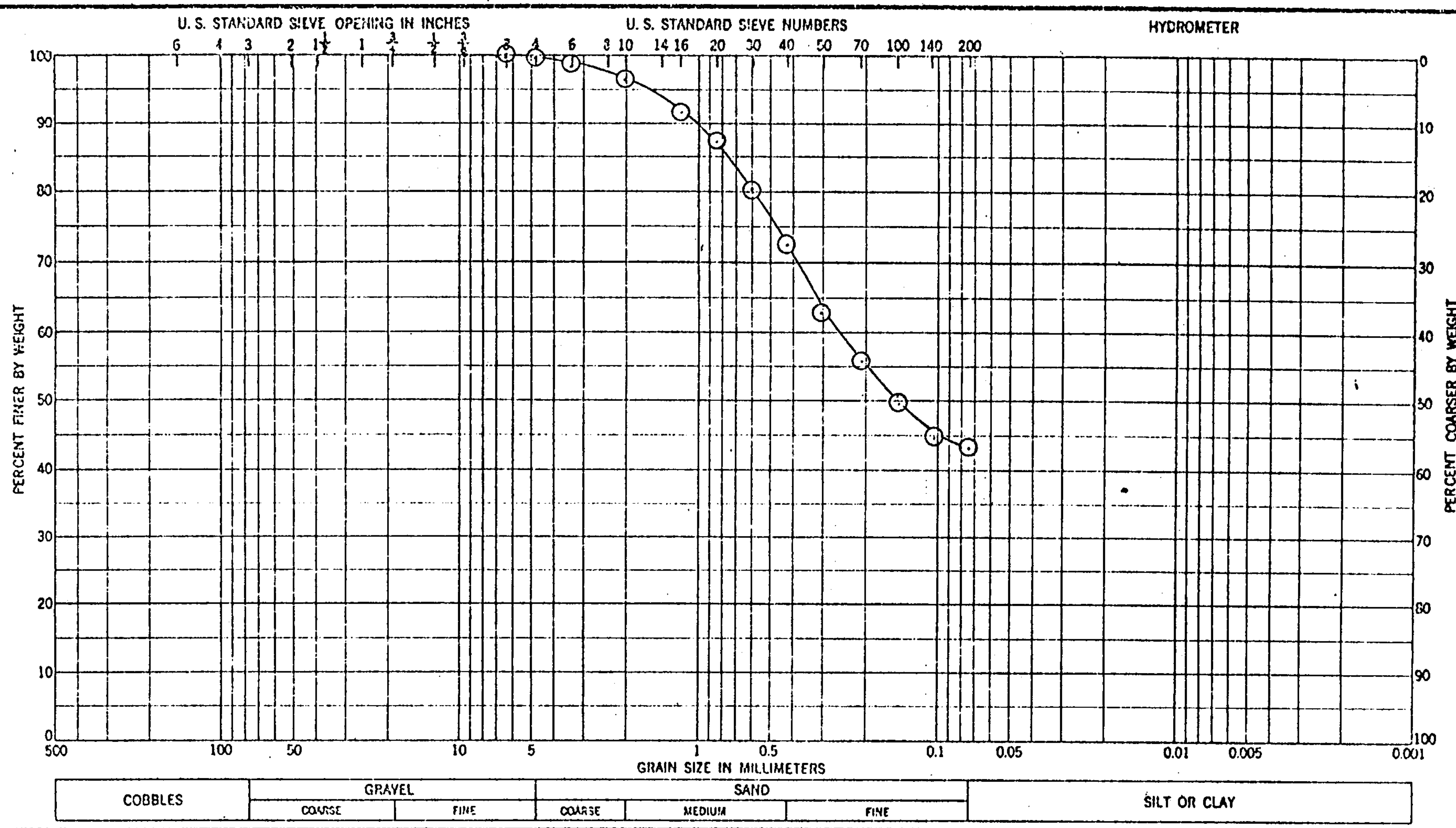
Boring No. D-1

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2037

PLATE 17



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	CLAYEY SAND(SC)	11.9			
		Tan				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

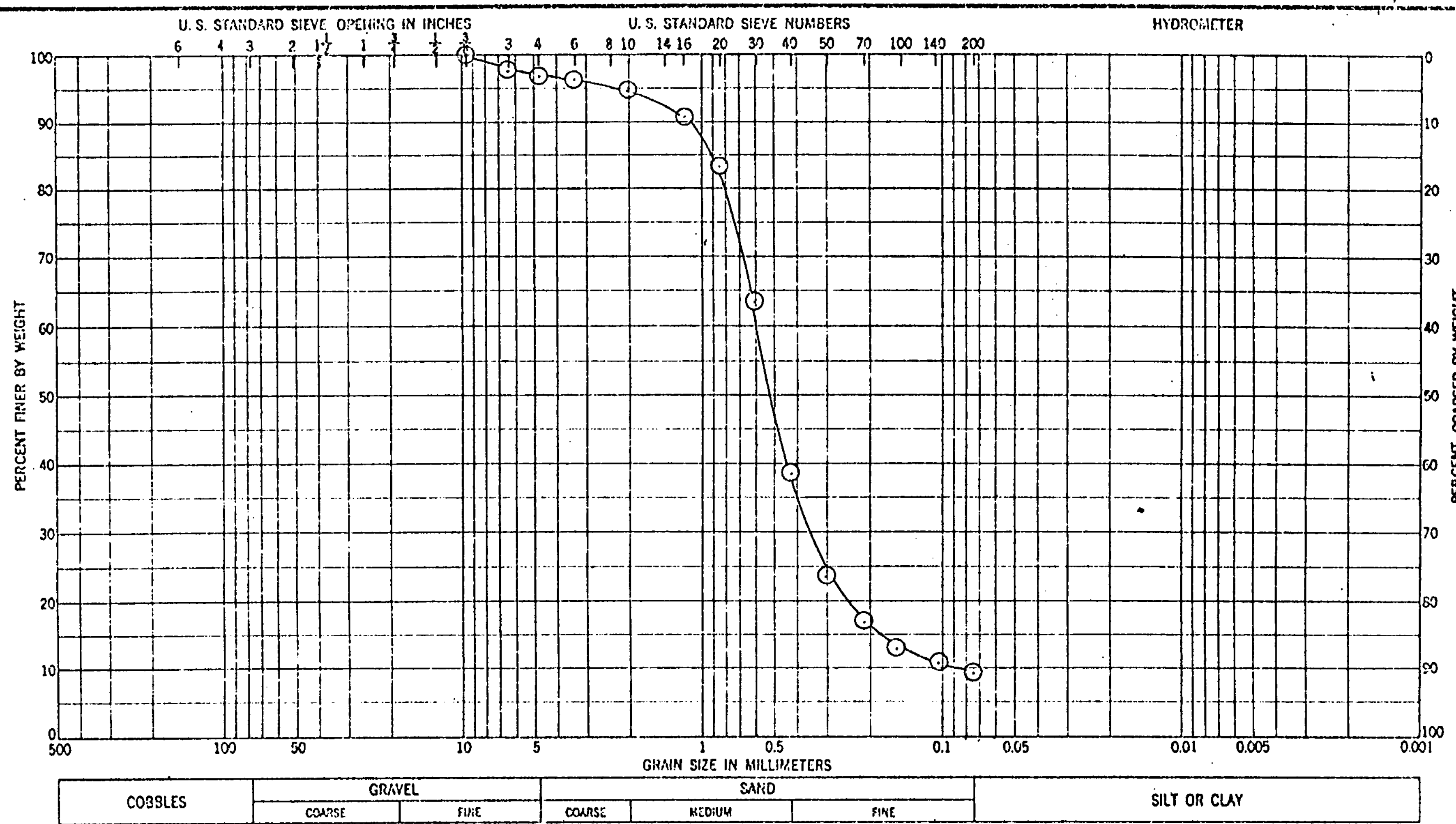
Area DEWATERING

Boring No. D-1

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SAND(SP-SM)	3.8	NP		
		With Trace Gravel				
		Brown				
		Gs= 2.65(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-1

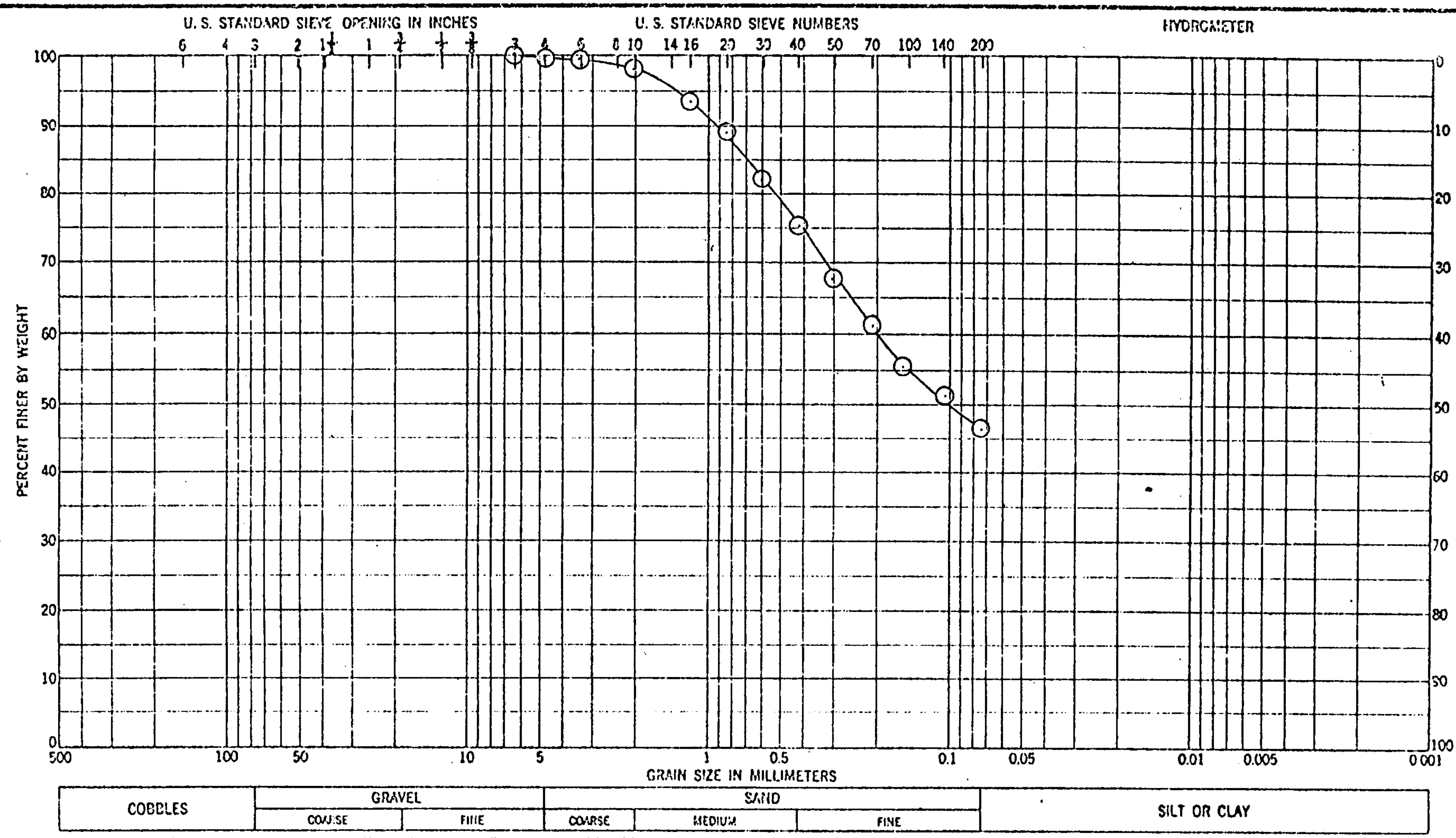
Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10}=.09

-200 = 9%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	CLAYEY SAND(SC) Light Gray Gs= 2.67(est)	15.8	25	15	10

Project ROCKY MOUNTAIN ARSENAL

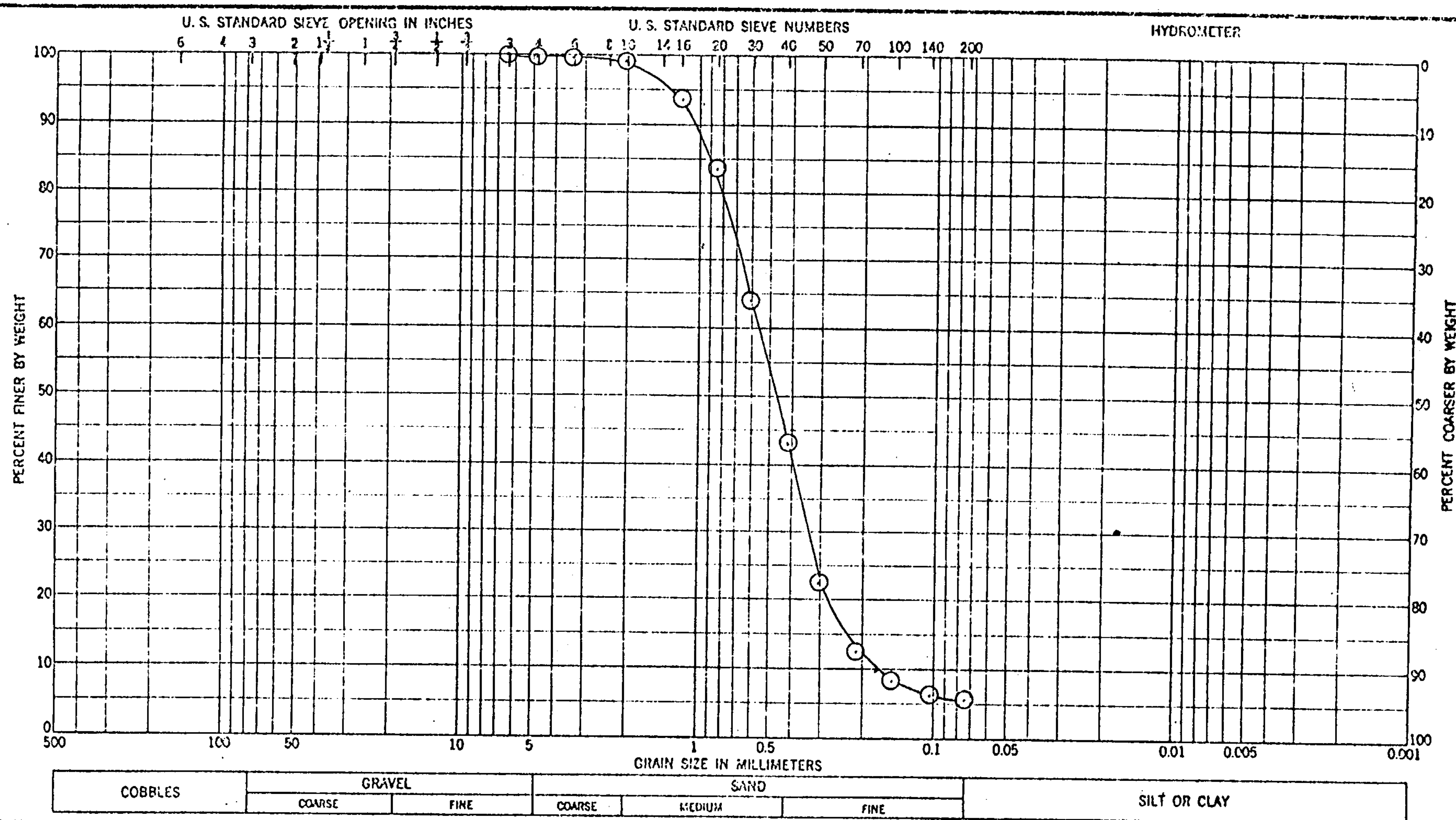
Area DEWATERING

Boring No. D-1

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20.0-21.5	SAND(SP-SM) Brown Gs= 2.65(est)	10.2	NP		

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-1

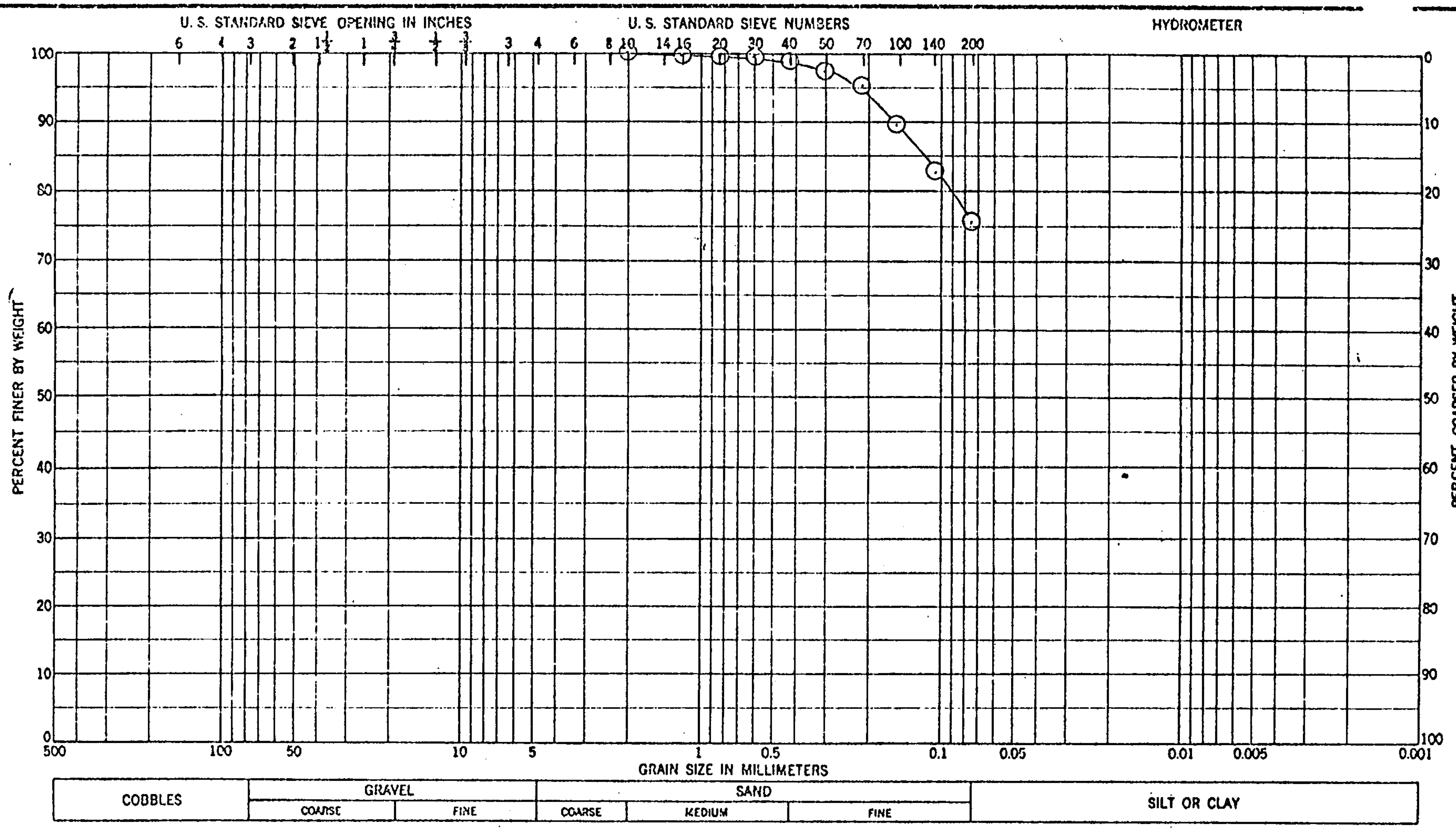
Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag D_{10} = 0.18

-200 = 6%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	25.0-26.5	SANDY, CLAYEY SILT(MH)	34.4	64	44	20
		Brown				
		Gs= 2.70(est)				

Project ROCKY MOUNTAIN ARSENAL

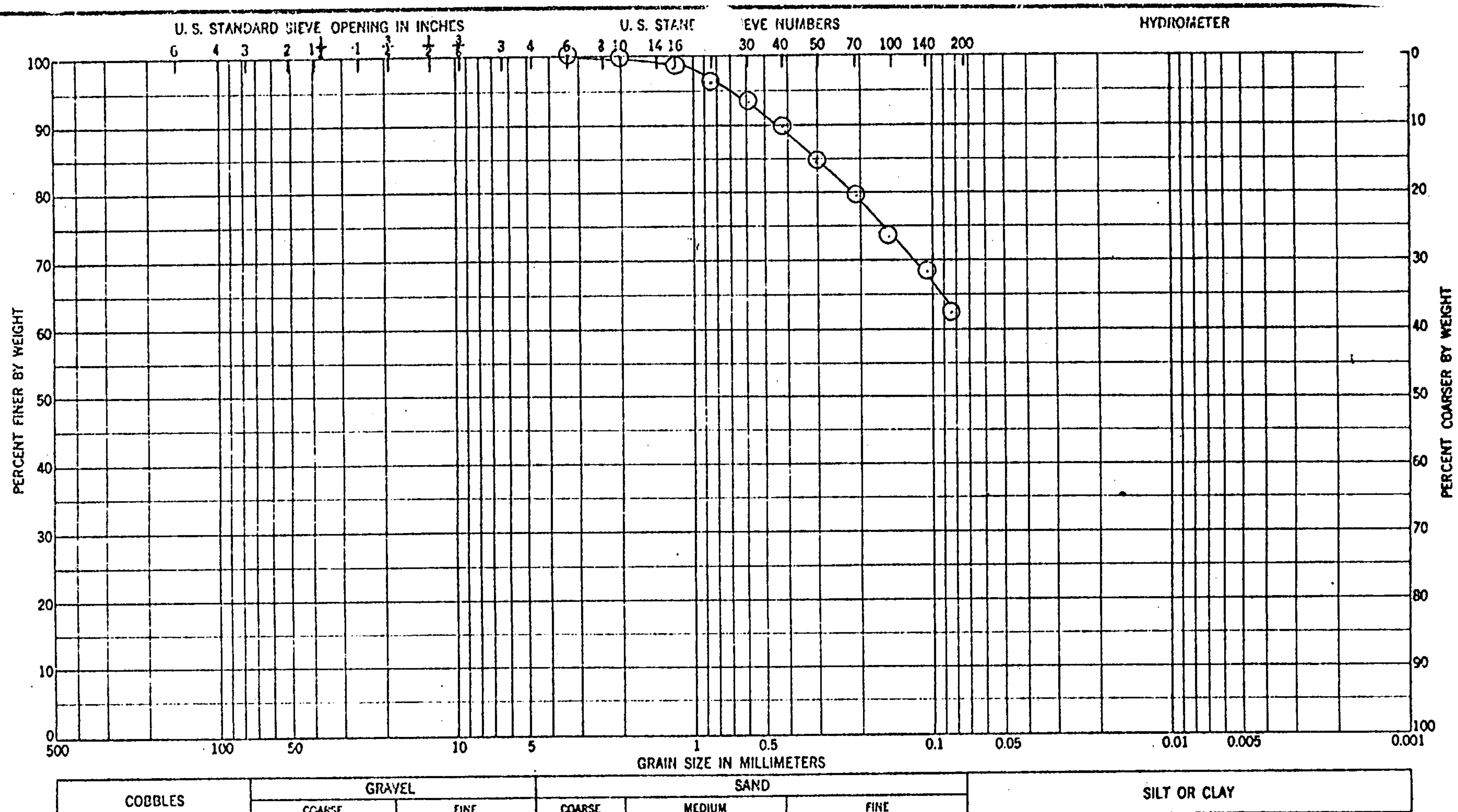
Area DEWATERING

Boring No. D-1

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	SANDY CLAY(CL) Brown Gs= 2.67(est)	20.8	40	18	22

GRADATION CURVES

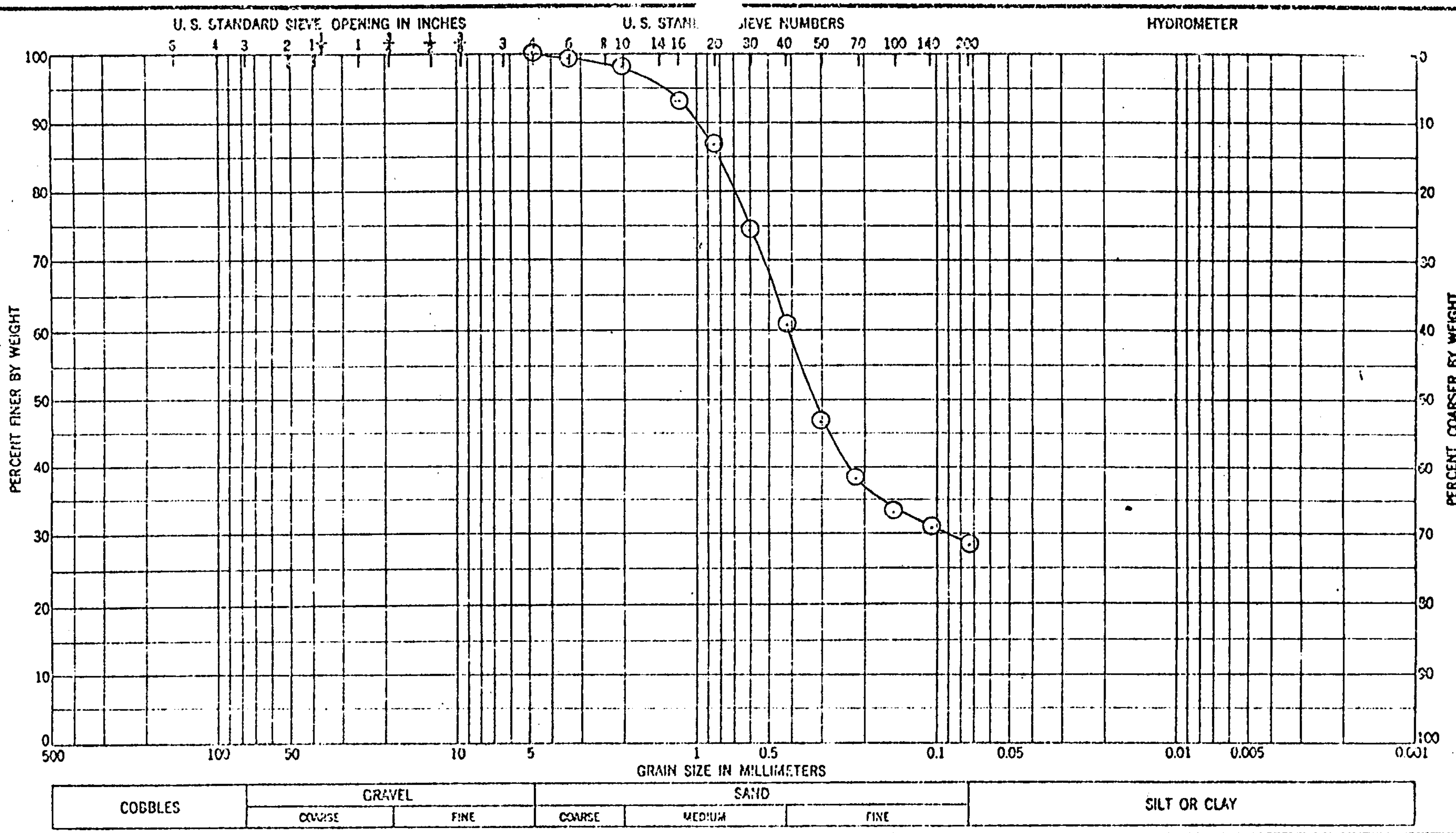
Project: ROCKY MOUNTAIN ARSENAL

Area: DEWATERING

Boring No.: D-2

Date: 23 August, 1976

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	CLAYEY SAND(SC)	12.4	31	15	16
		Light Brown				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

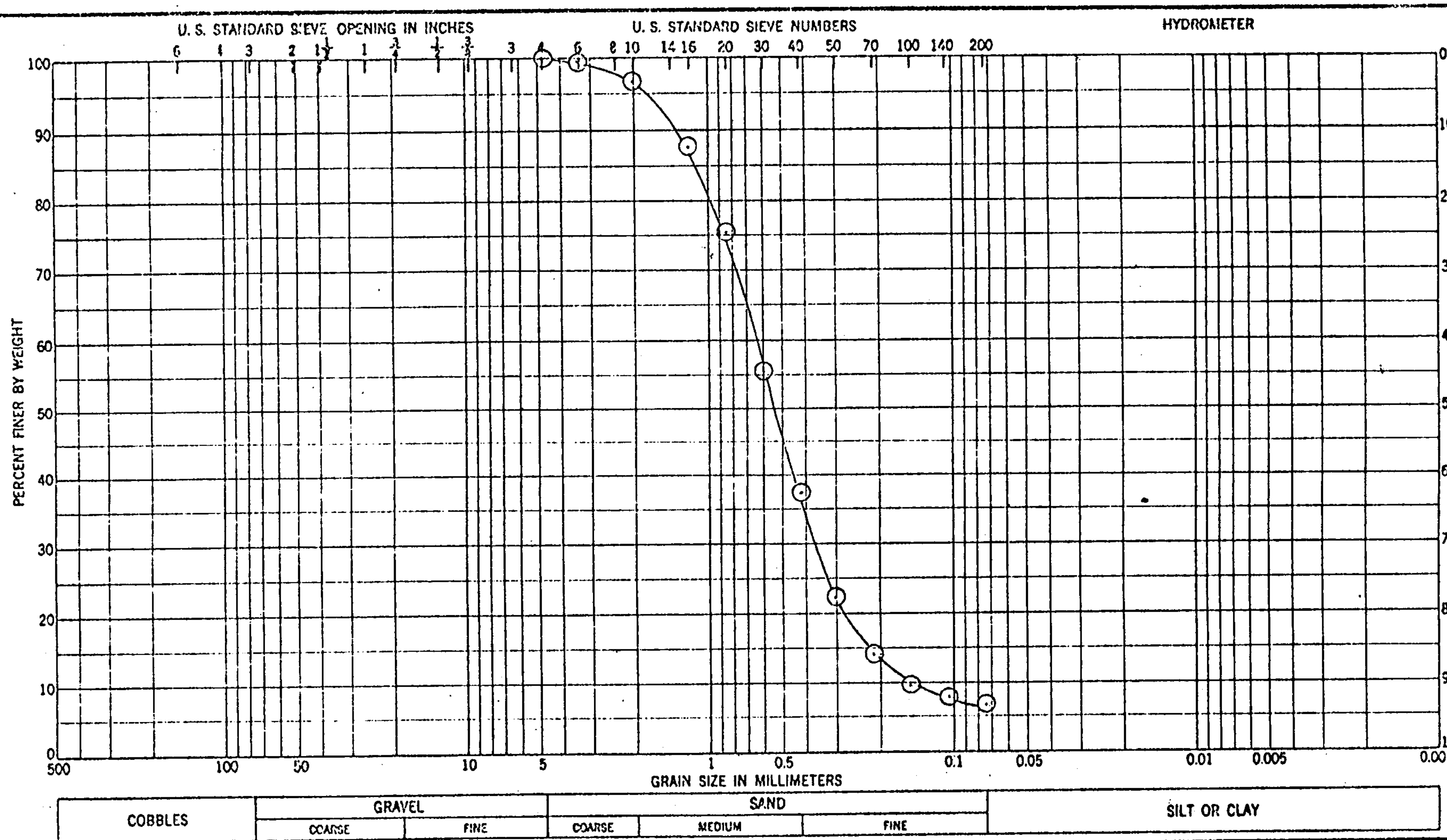
Area DEWATERING

Boring No. D-2

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND(SP-SM)	11.3	NP		
		Tan				
		Gs= 2.65(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-2

Date 23 August, 1976

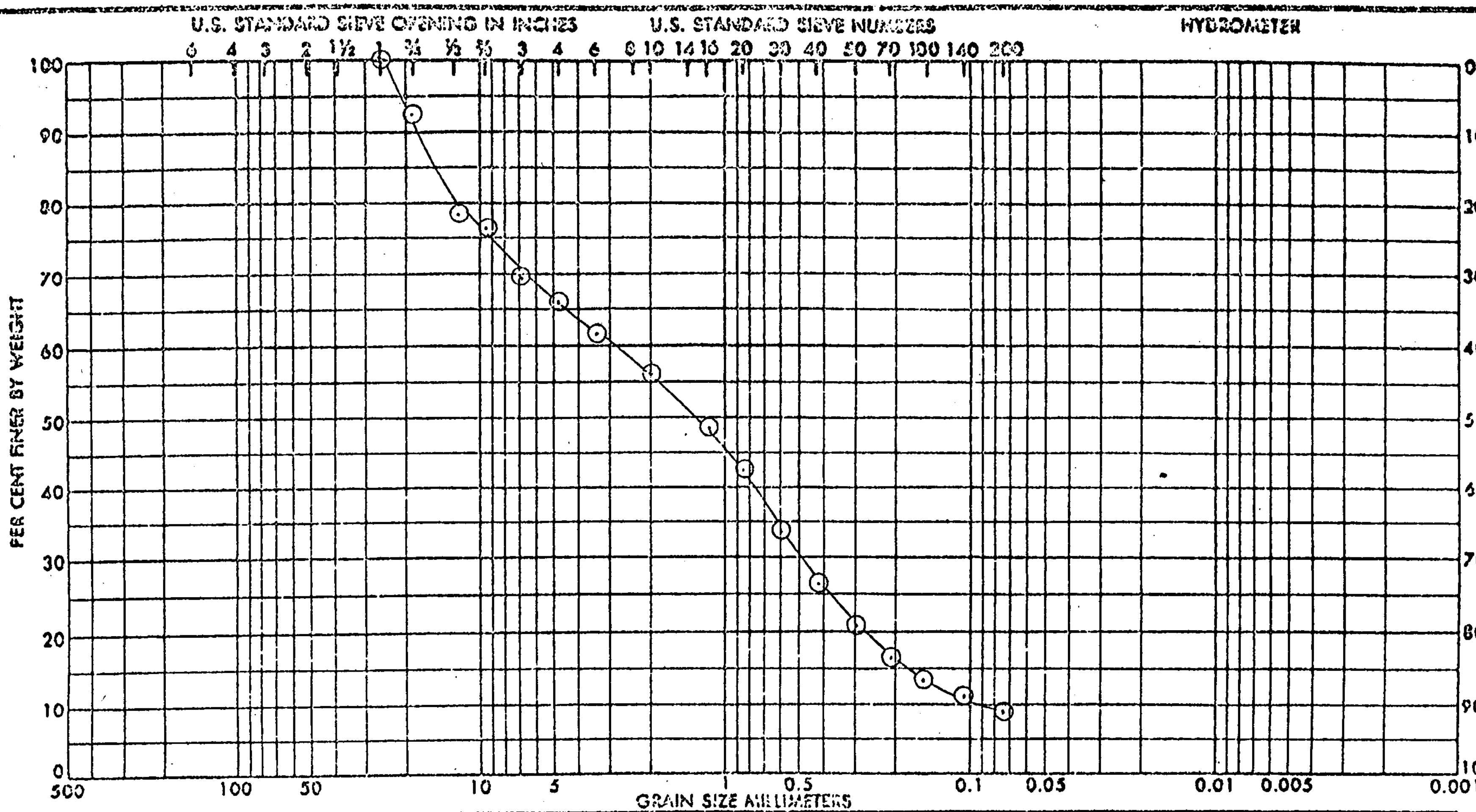
GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag D_{10} = 0.15

-200 = 7%

PLATE 25



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	20.0-21.5	GRAVELLY SAND (SP-SM)	11.0	NP		
		Brown				
		Gs= 2.66(est)				

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	D-2
DATE	27 August, 1976

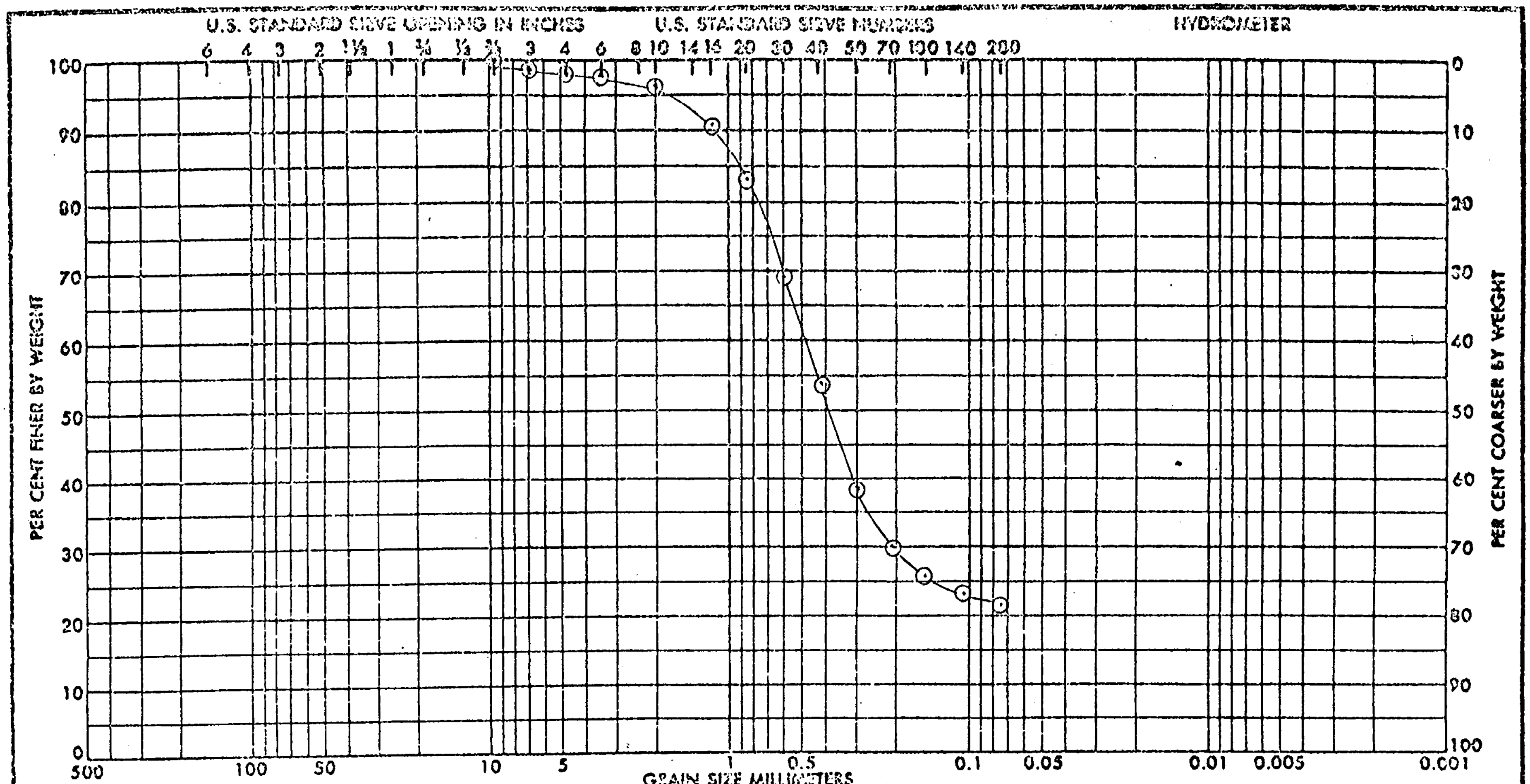
GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—799-124

Ag. D_{10} = 0.095
-200 = 8%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	5.0-6.5	CLAYEY SAND (SC)	7.7	30	13	17
		Brown				
		Gs= 2.66(est)				

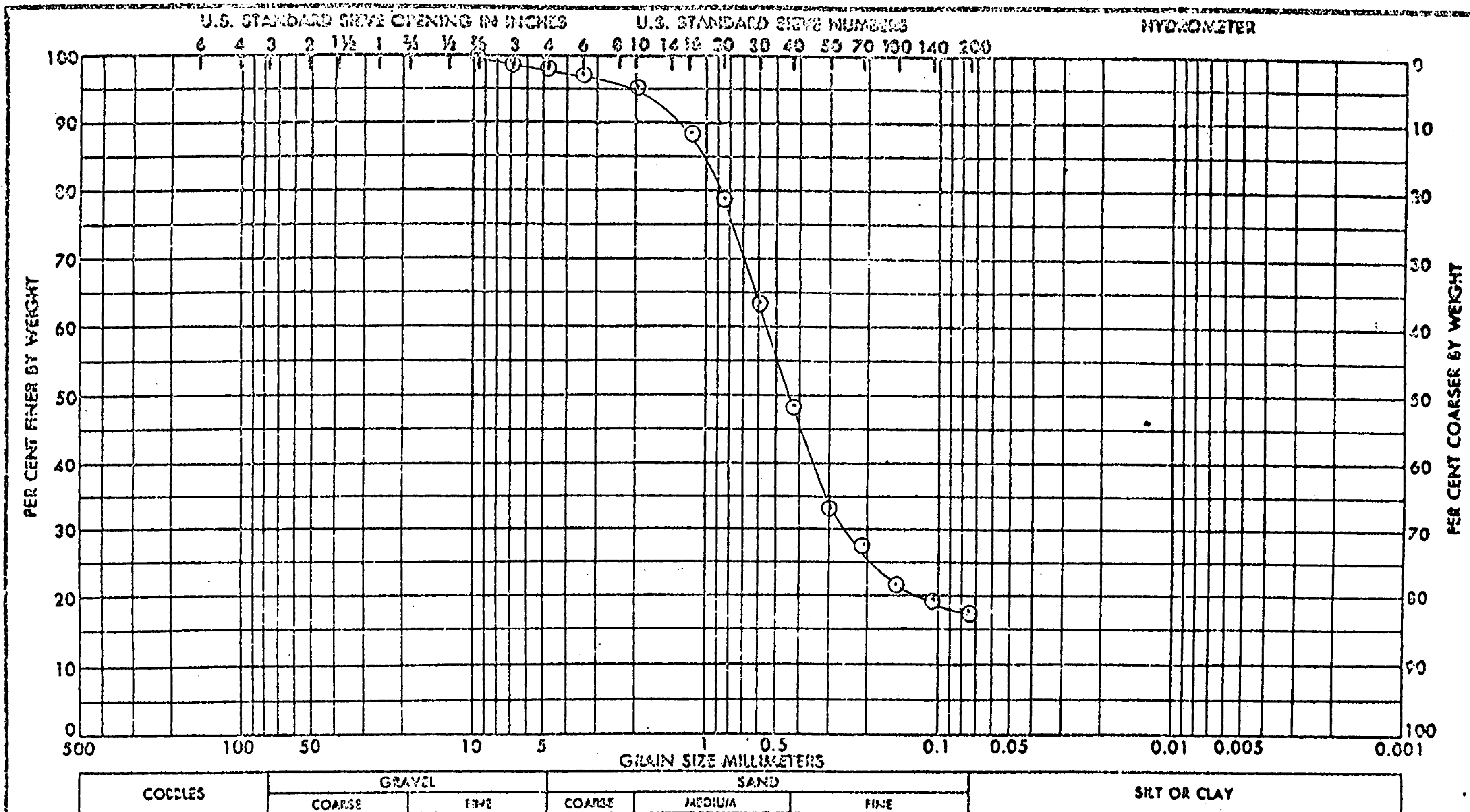
GRADATION CURVES

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	D-3
DATE	27 August, 1976

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—750-158

Ag Do



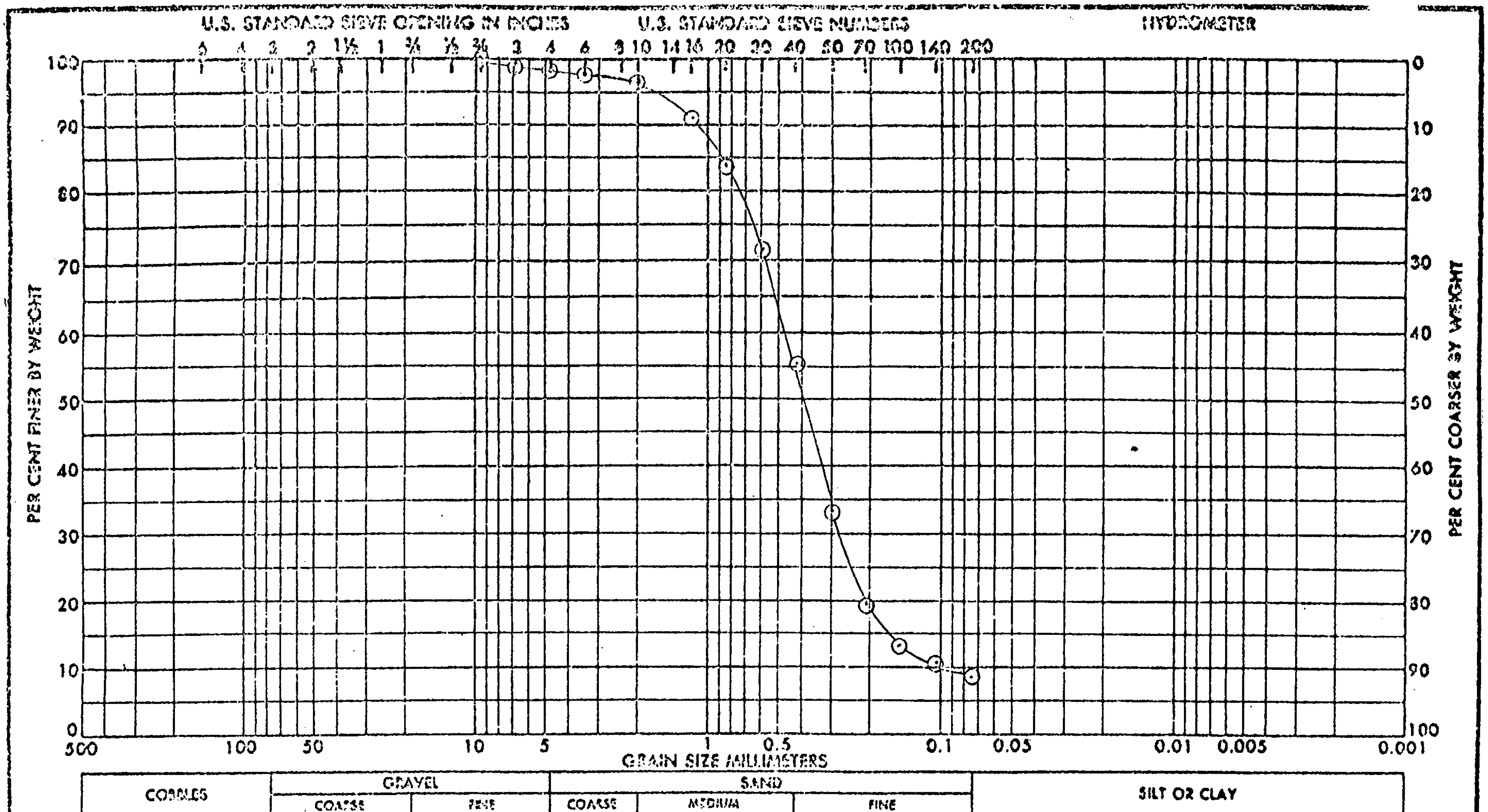
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	10.0-11.5	CLAYEY SAND(SC)	26.3	37	22	15
		Tan				
		Gs= 2.66(est)				

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	D-3
DATE	27 August, 1976

GRADATION CURVES

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—700-128



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	15.0-16.5	SAND(SP-SM)	19.3	NP		
		Brown				
		Gs= 2.66(est)				

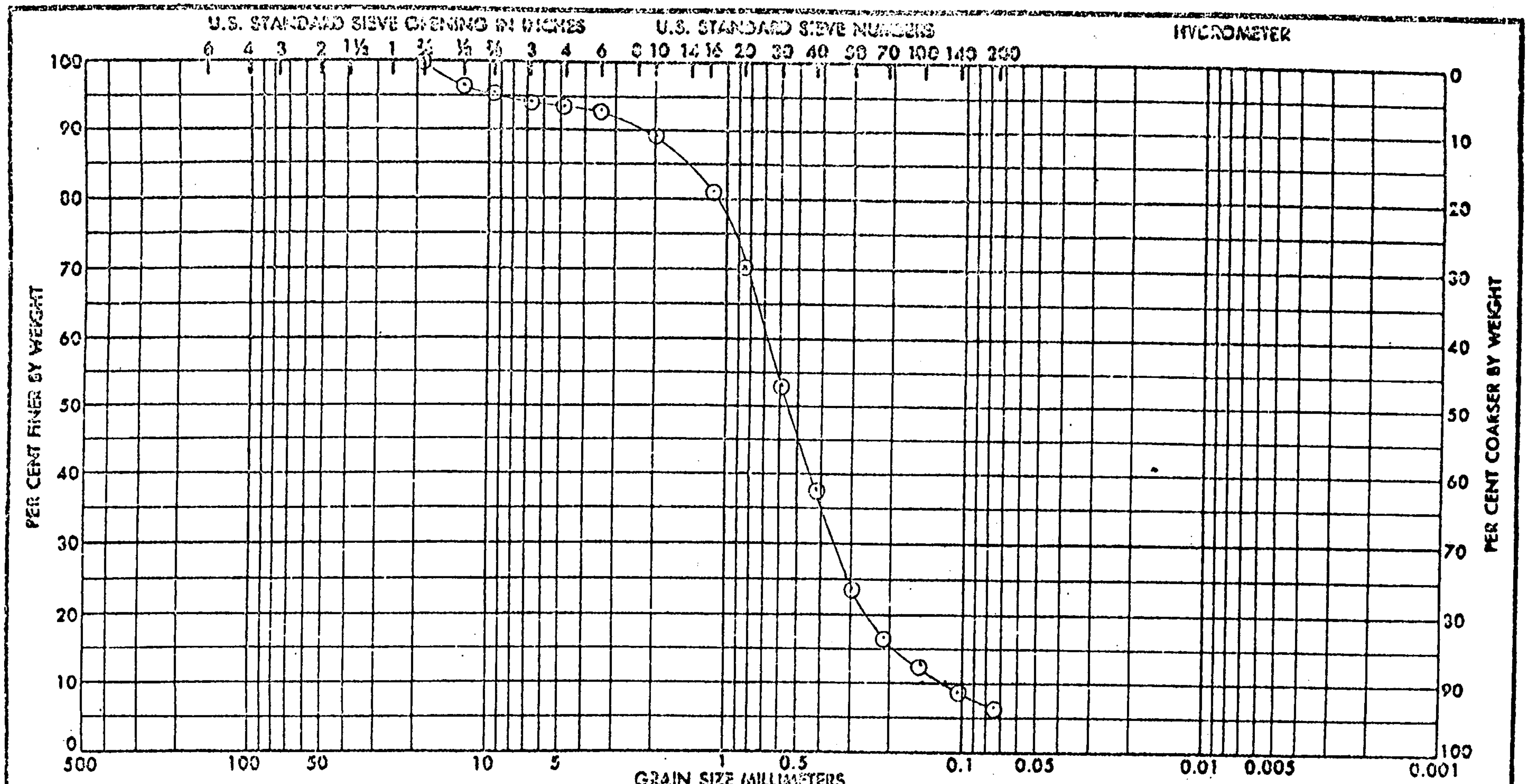
GRADATION CURVES

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	0-3
DATE	27 August, 1976

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

Ag D_{10} = 0.10
-200 = 9%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	20.0-21.5	SAND(SP-SM)	9.8	NP		
		Brown				
		Gs= 2.66(est)				
		With Gravel				

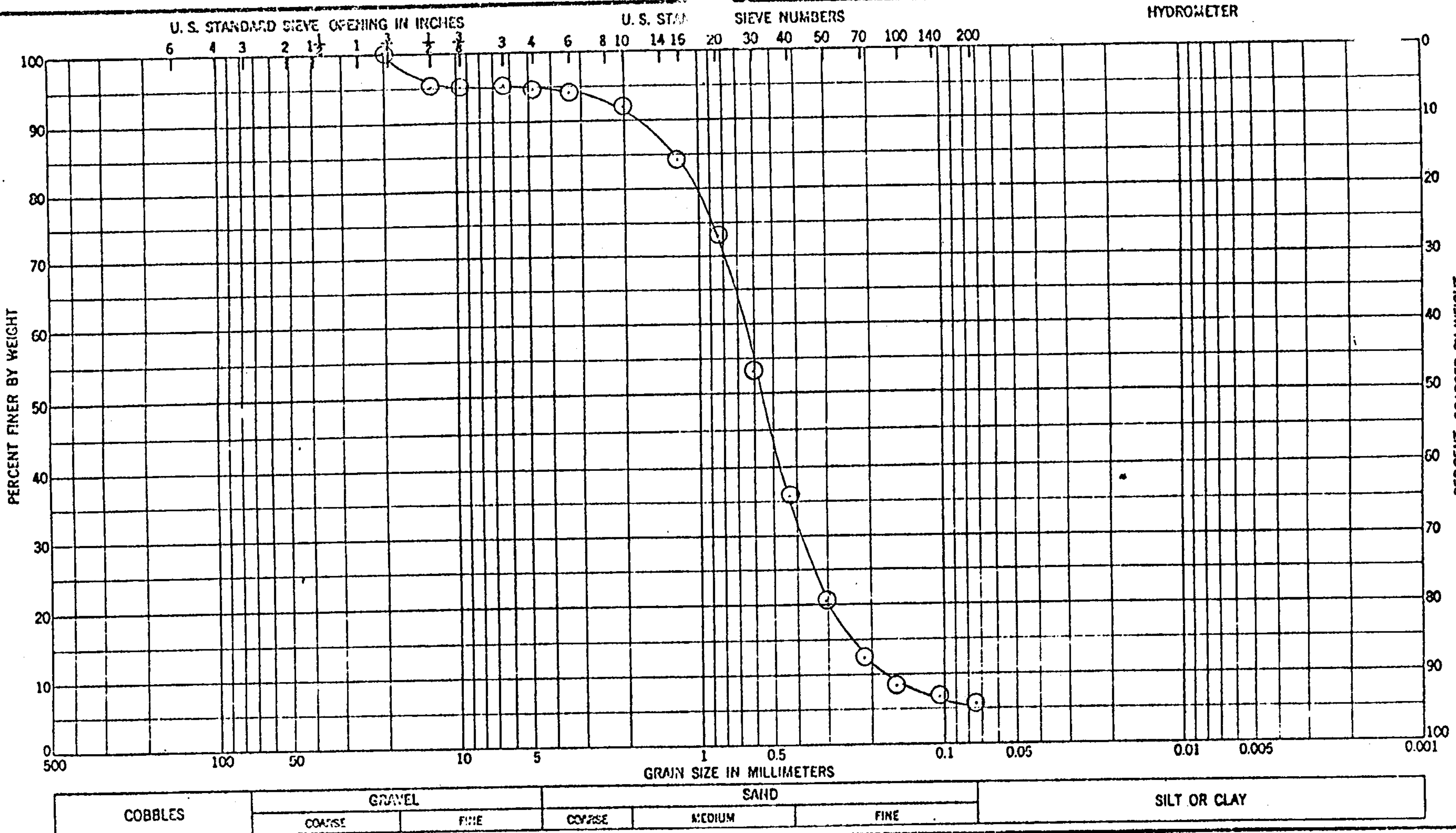
PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	D-3
DATE	27 August, 1976

GRADATION CURVES

ENG FORM 2087 1 MAY 63 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—703-128

Ag $D_{10} = 0.11$
$-200 = 7\%$



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6-A	25.0-25.8	SAND(SP-SM)	19.2	NP		
		With Trace Gravel				
		Brown				
		Gs= 2.66(est)				

Project: ROCKY MOUNTAIN ARSENAL

Area: DEWATERING

Boring No. D-3

Date: 3 Sept., 1976

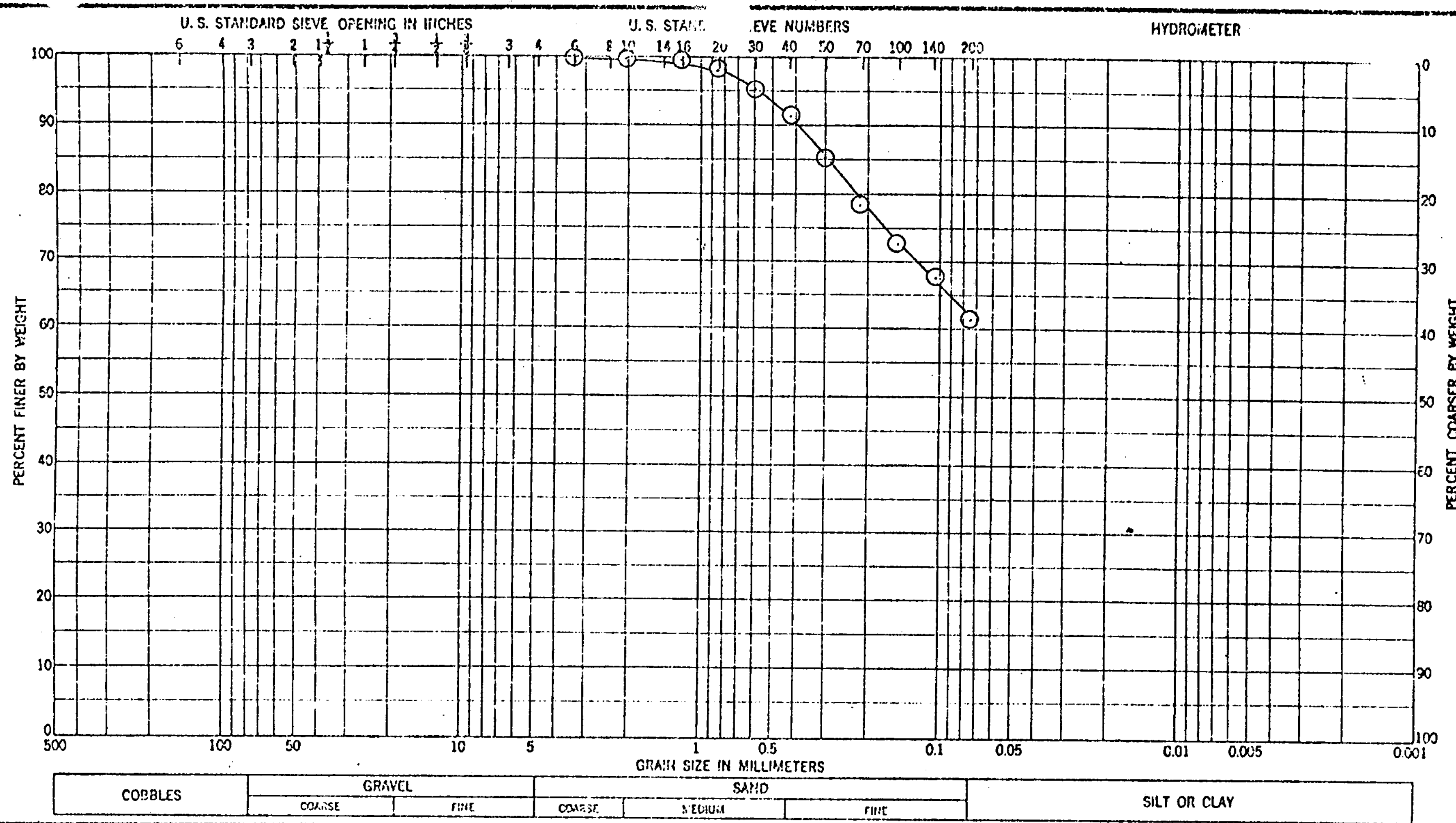
GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 31

Ag. $D_{10} = 0.18$

$-200 = 6\%$



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	SANDY CLAY(CL)	23.5	35	14	21
		Brown				
		Gs= 2.67(est)				

Project ROCKY MOUNTAIN ARSENAL

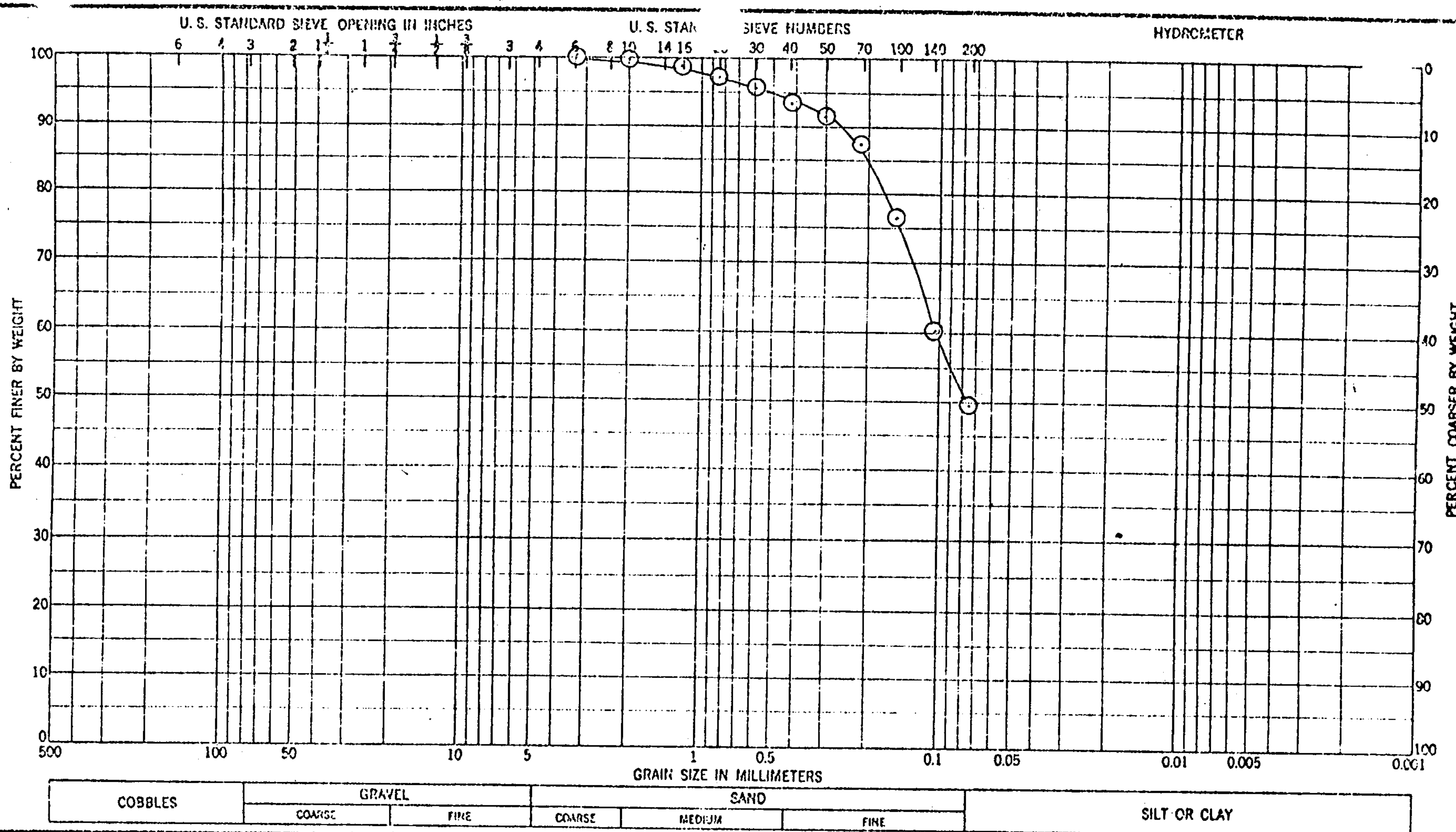
Area DEWATERING

Boring No. D-4

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SILTY SAND (SM) Brown Gs= 2.66(est)	19.7	NP		

Project ROCKY MOUNTAIN ARSENAL

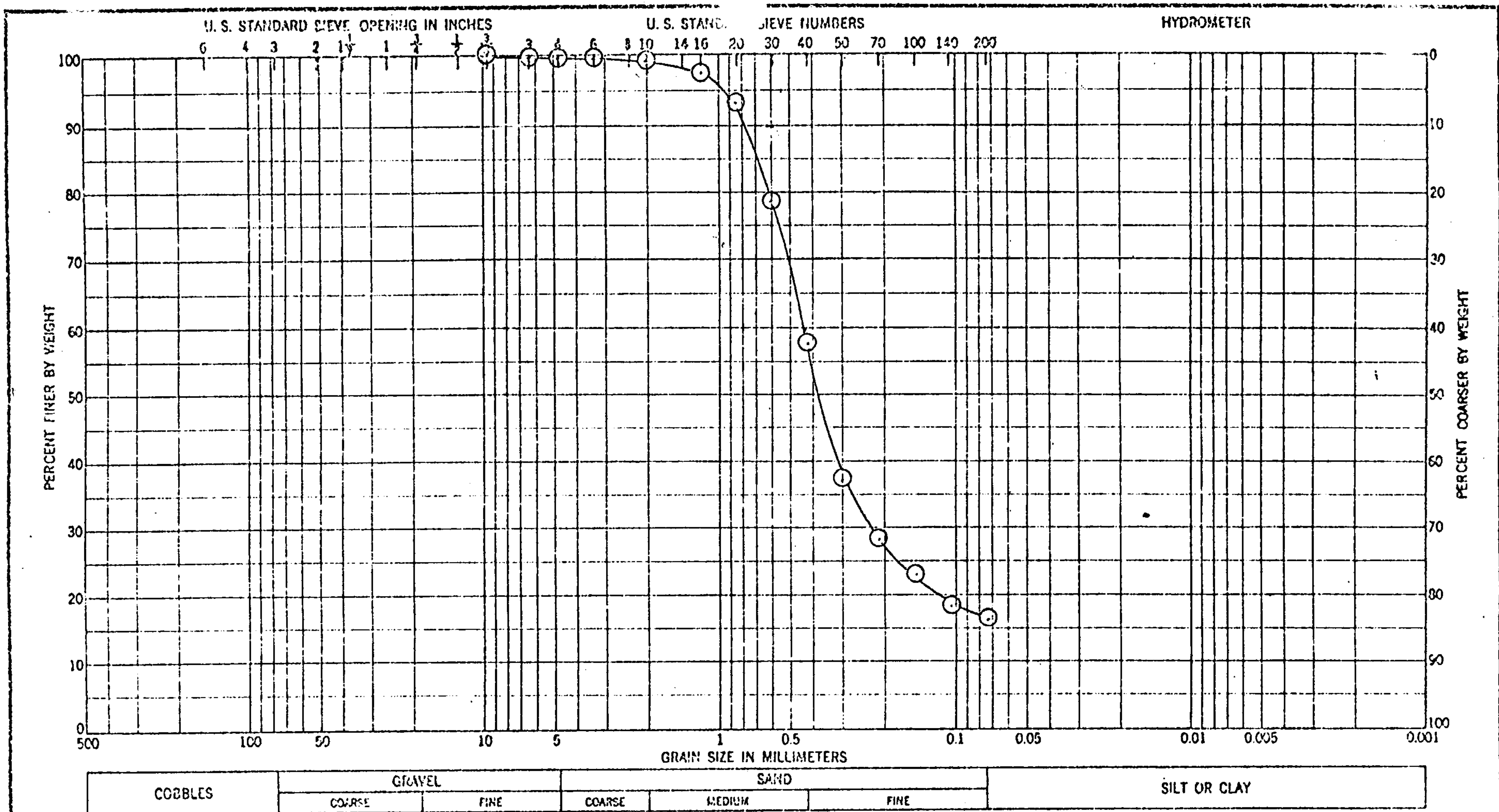
Area DEWATERING

Boring No. D-4

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SILTY SAND(SM)	16.8	NP		
		Brown				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

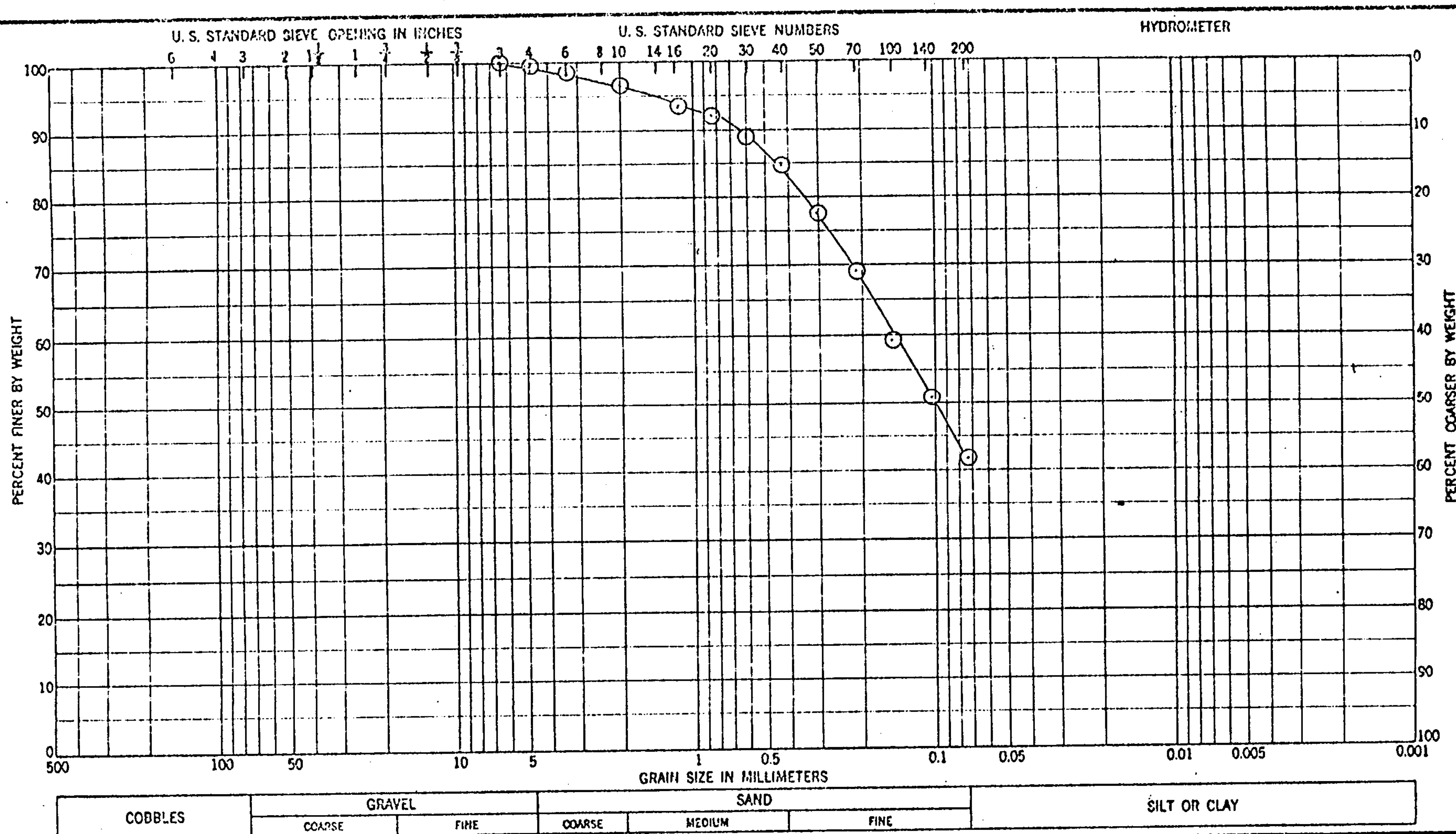
Boring No. D-4

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10} = less than 0.074
-200 @ 17%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	CLAYEY SAND(SC) Light Brown Gs= 2.66(est.)	13.5	29	13	16

Project: ROCKY MOUNTAIN ARSENAL

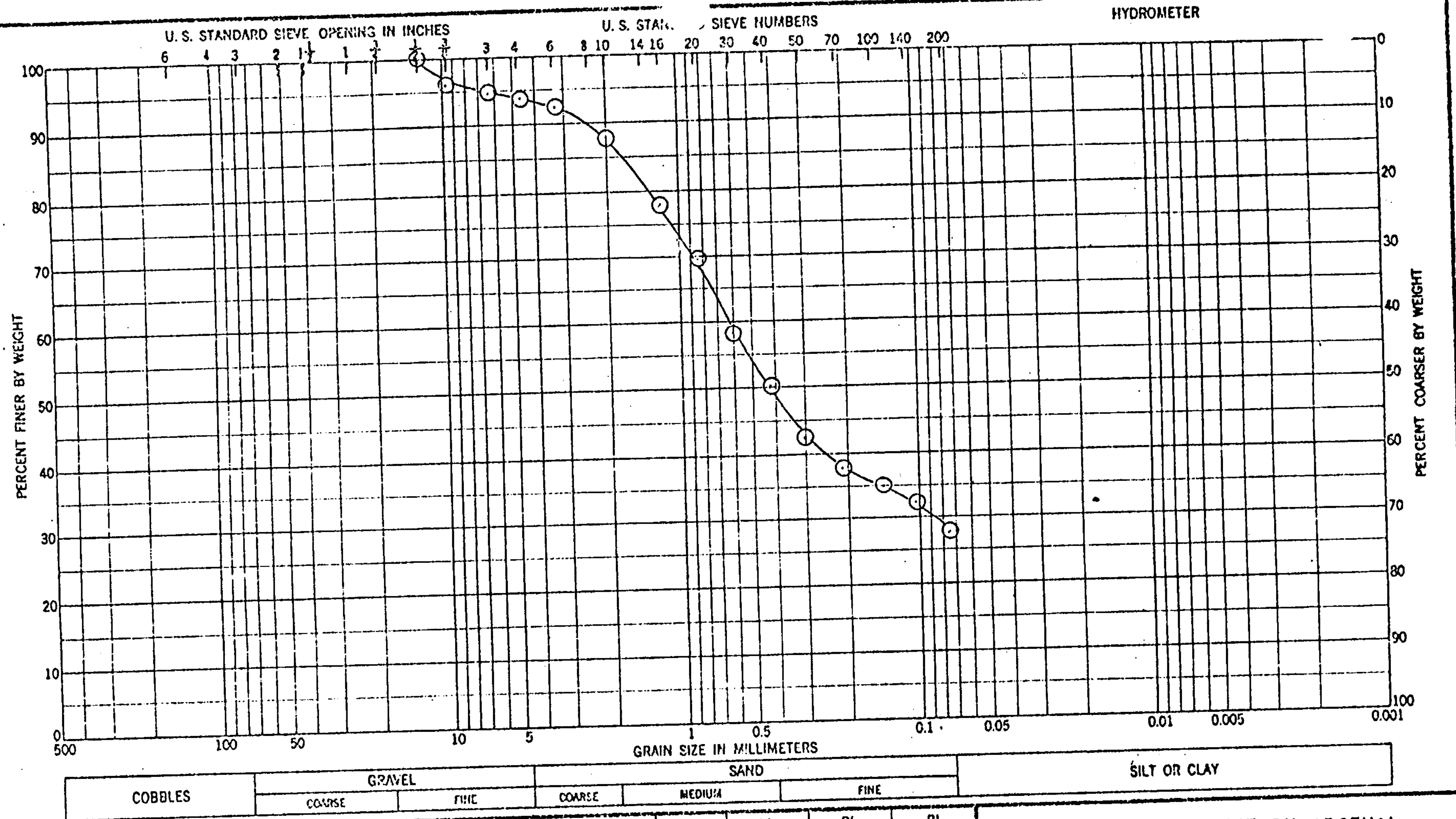
Area: DEWATERING

Boring No. D-5

Date: 10 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SILTY SAND(SM)	20.1	NP		
		Brown				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

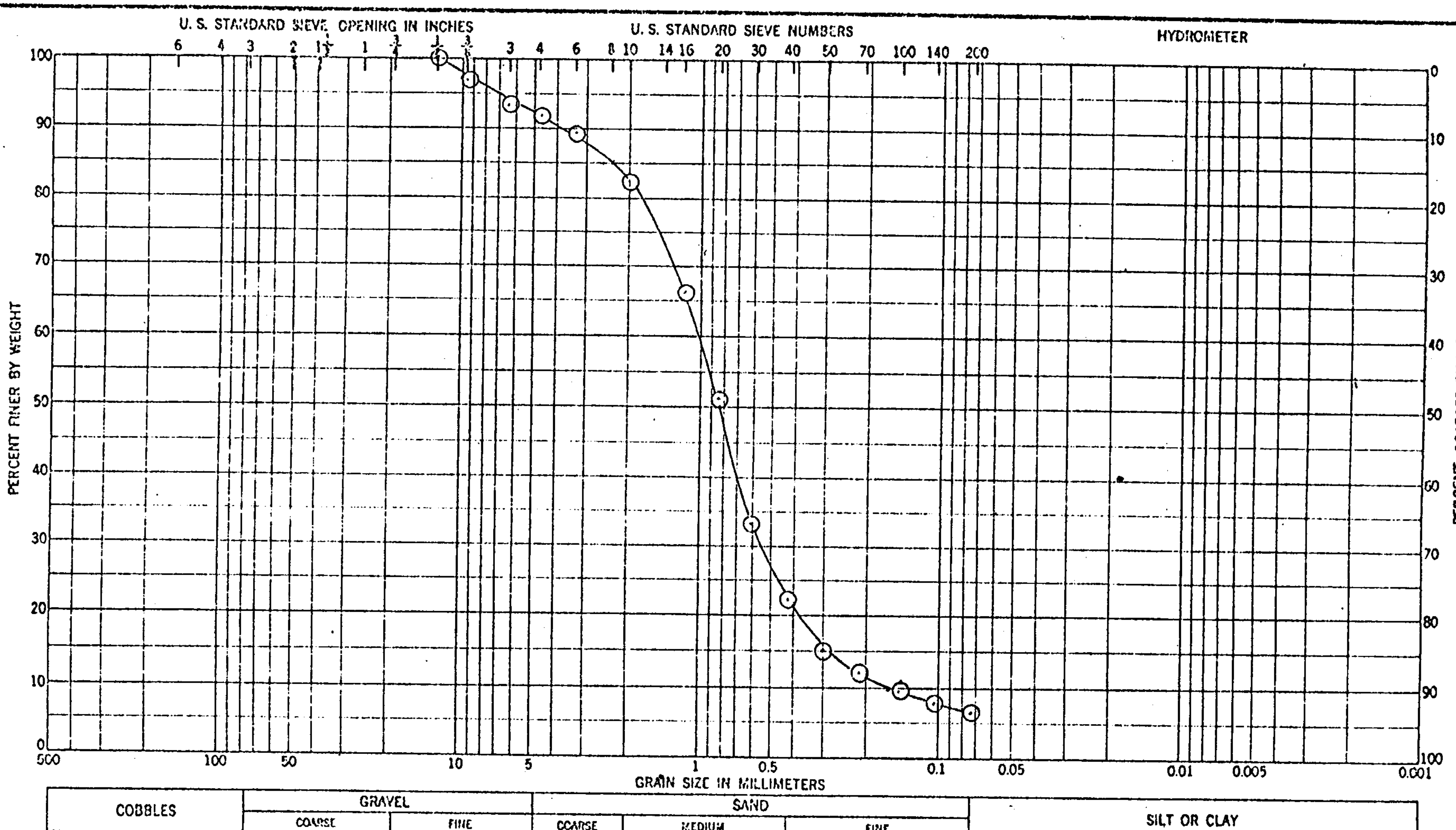
Area DEWATERING

Boring No. D-5

Date 10 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND (SP-SM) With Gravel Brown Gs= 2.66(est)	13.3	NP		

Project: ROCKY MOUNTAIN ARSENAL

Area: DEWATERING

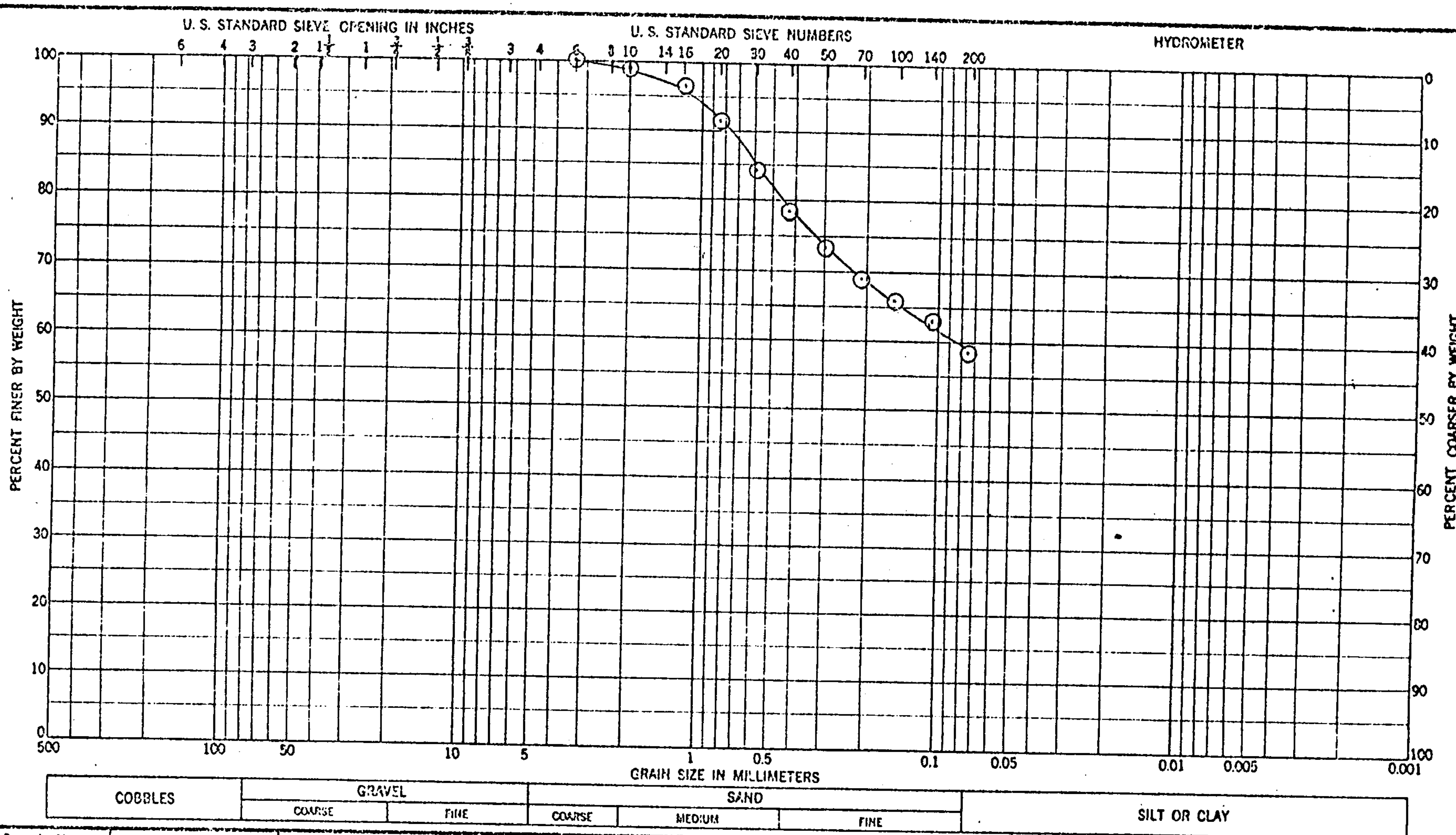
Boring No.: D-5

Date: 24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10} = 0.17
-200 7%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	25.0-25.5	SANDY CLAY(CL) Brown Gs= 2.70(est)	23.9	32	14	18

GRADATION CURVES

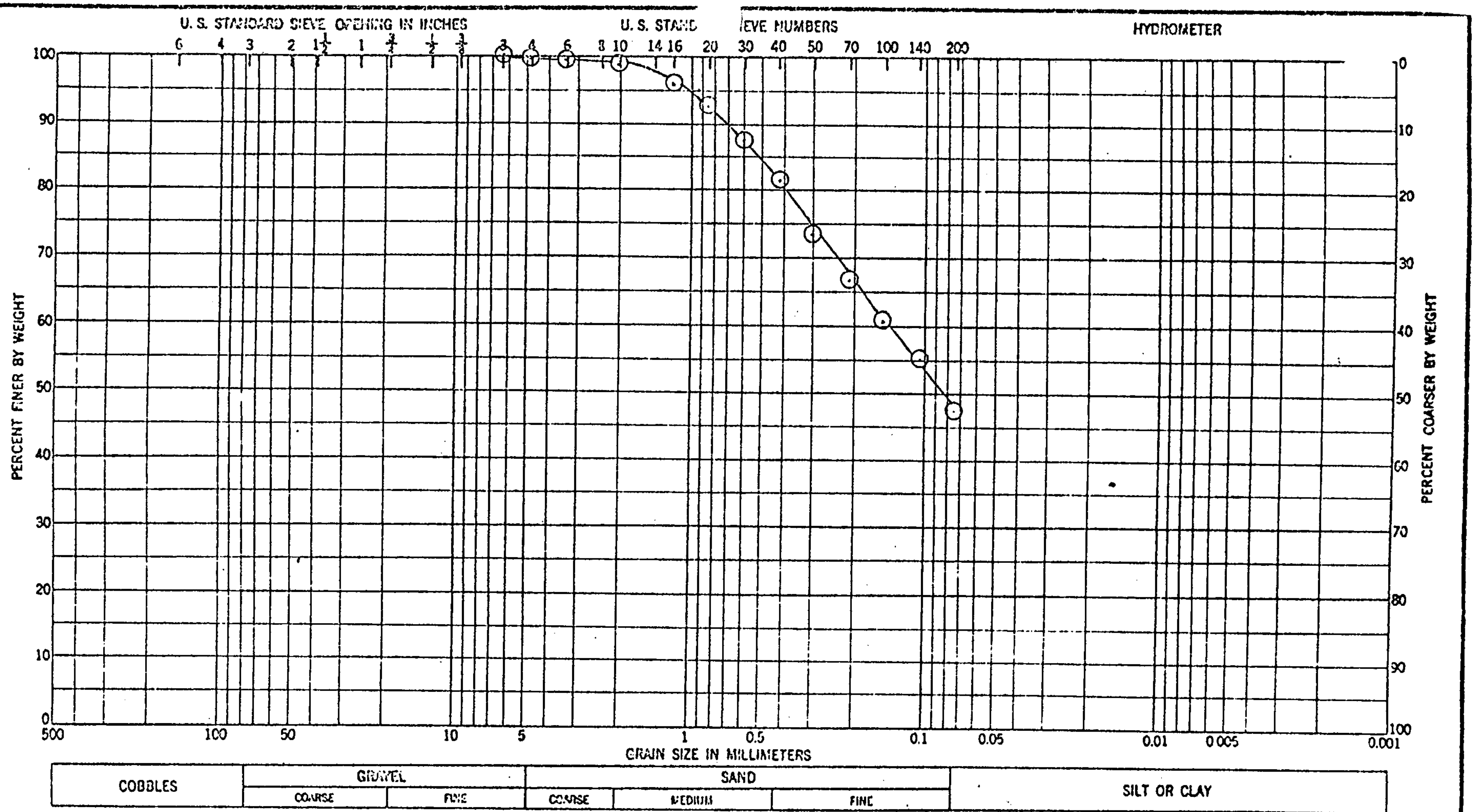
Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-5

Date 10 August, 1976

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	0.0-1.5	CLAYEY SAND(SC)	8.6	28	14	14
		Brown				
		Gs= 2.67(est)				

Project ROCKY MOUNTAIN ARSENAL

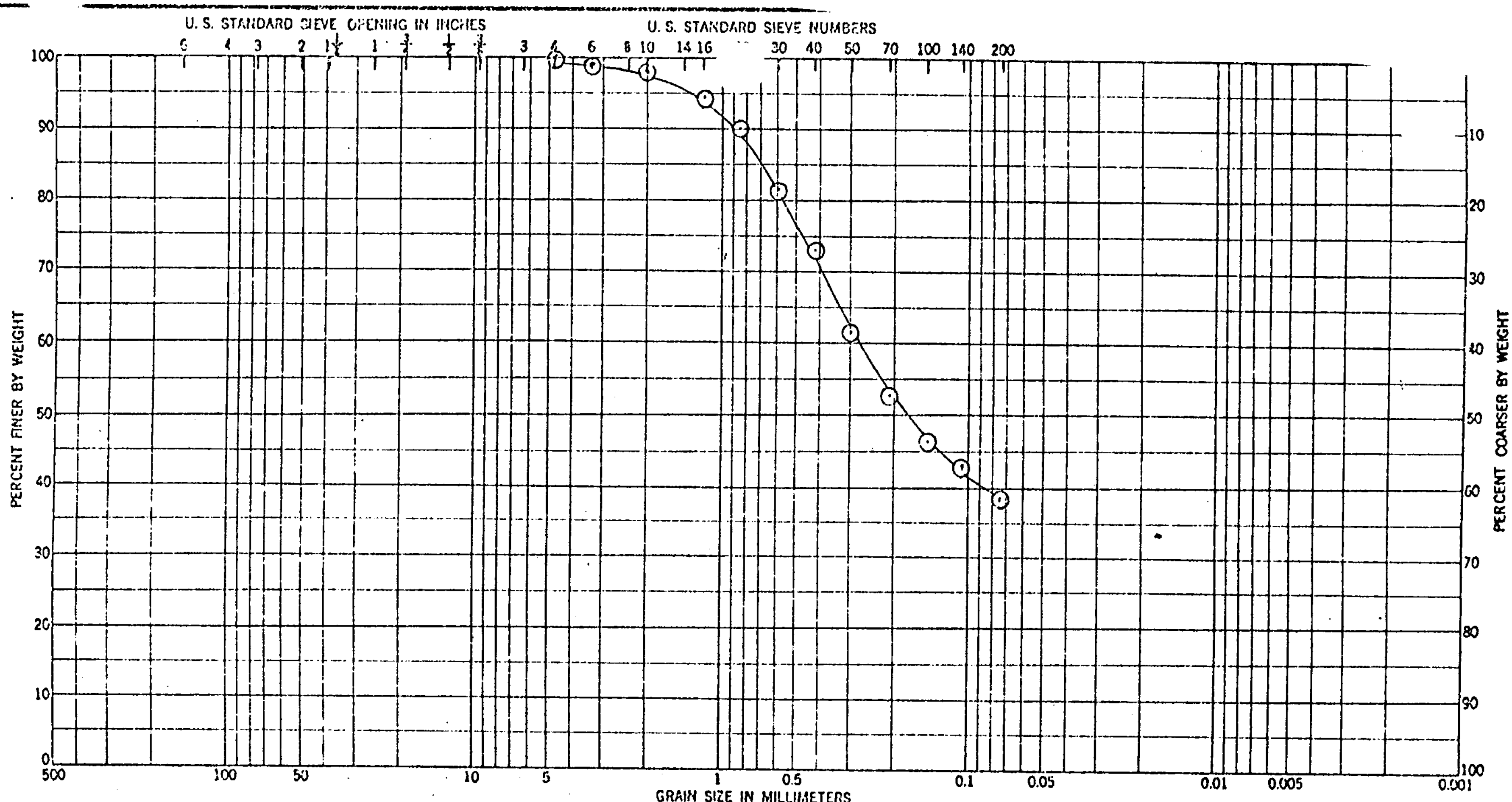
Area DEWATERING

Boring No. U-6

Date 2 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	CLAYEY SAND (SC)	15.2	33	12	21
		Tan				
		Gs= 2.66(est)				

Project: ROCKY MOUNTAIN AESENAL

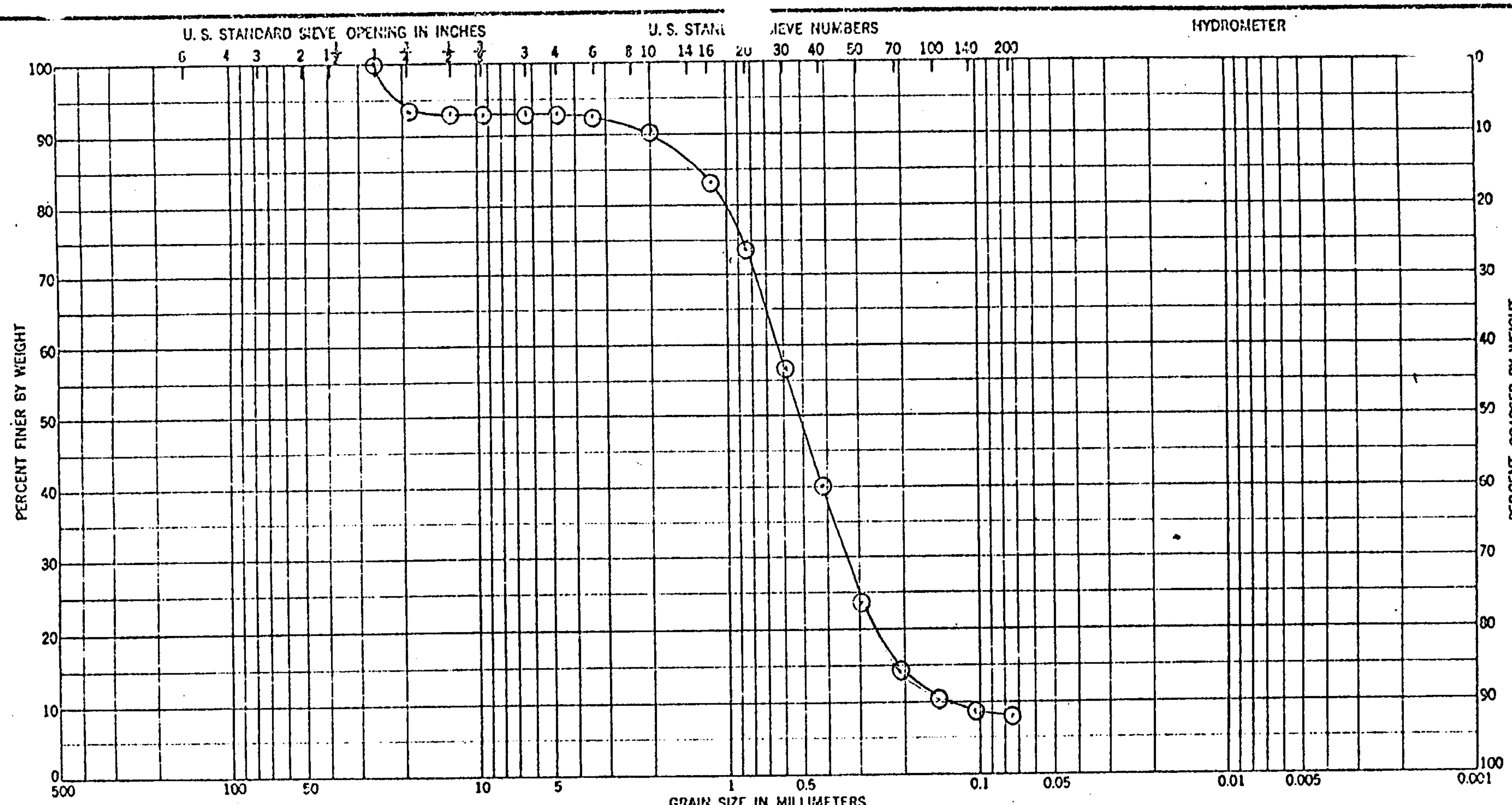
Area: DEWATERING

Boring No.: D-6

Date: 24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SAND(SP-SM)	8.7	NP		
		Tan				
		With Gravel				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

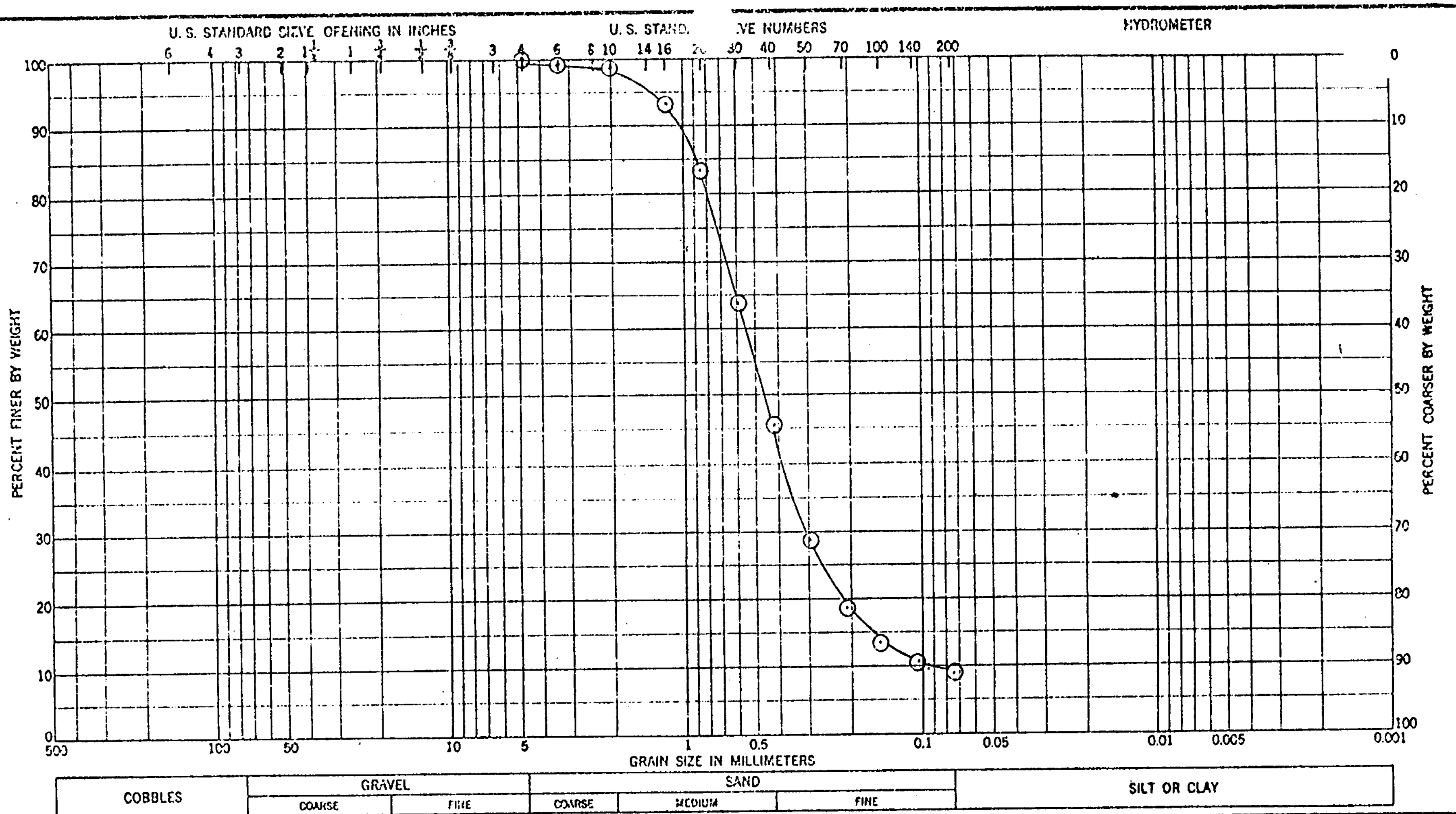
Boring No. D-6

Date 24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. $D_{10} = 0.13$
$-200 : 8\%$



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND(SP-SM)	17.2	NP		
		Brown				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-6

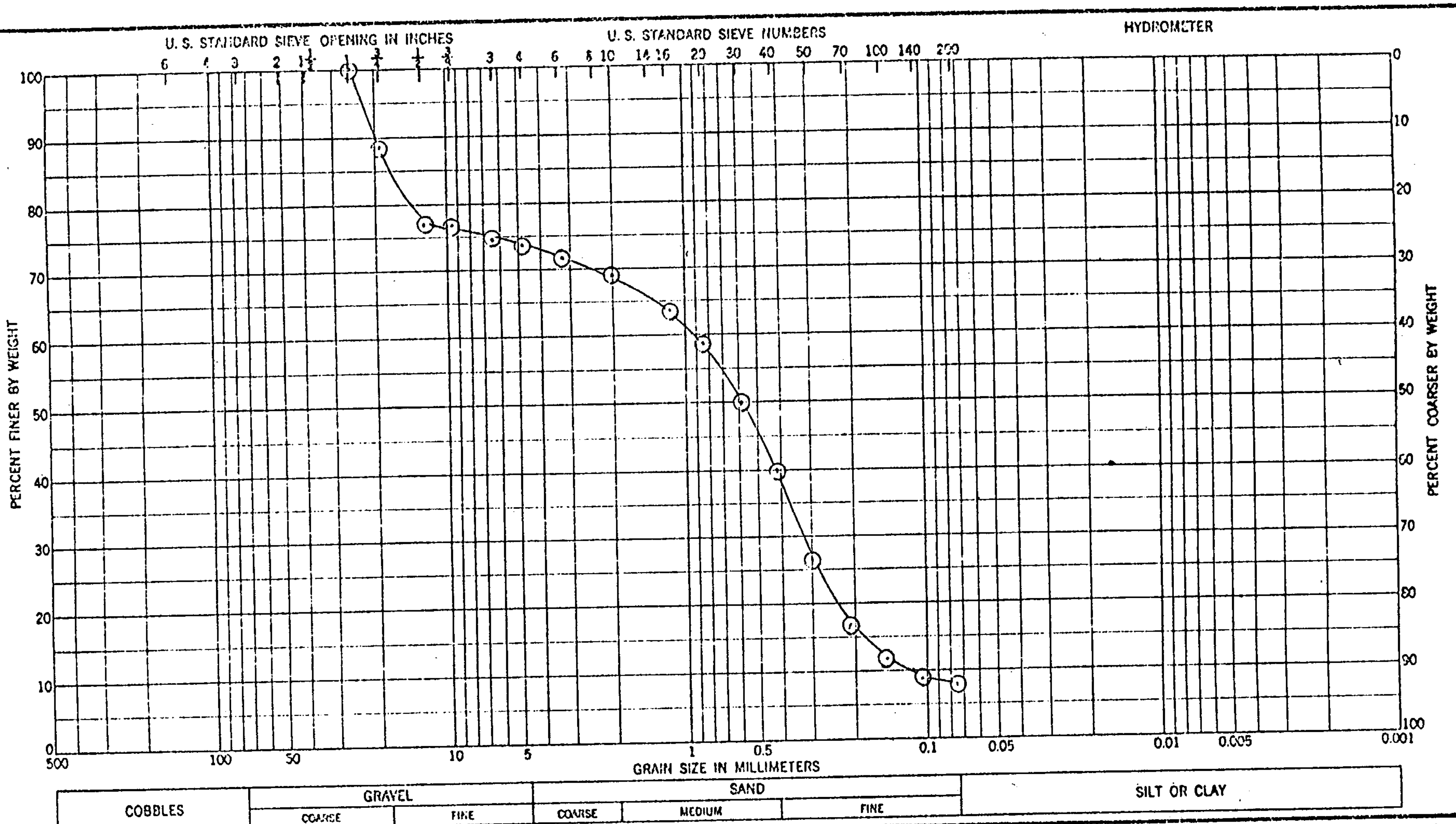
Date 24 August, 1976

GRADATION CURVES

PLATE 42

ENG FORM 1 MAY 63 2087

Ag. D_{10} = 0.092
-200 = 9%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20.0-21.5	GRAVELLY SAND(SP-SM)	15.1	NP		
		Tan				
		Gs= 2.66(est)				

Project ROCKY M(UNTAIN ARSENAL

Area DEWATERING

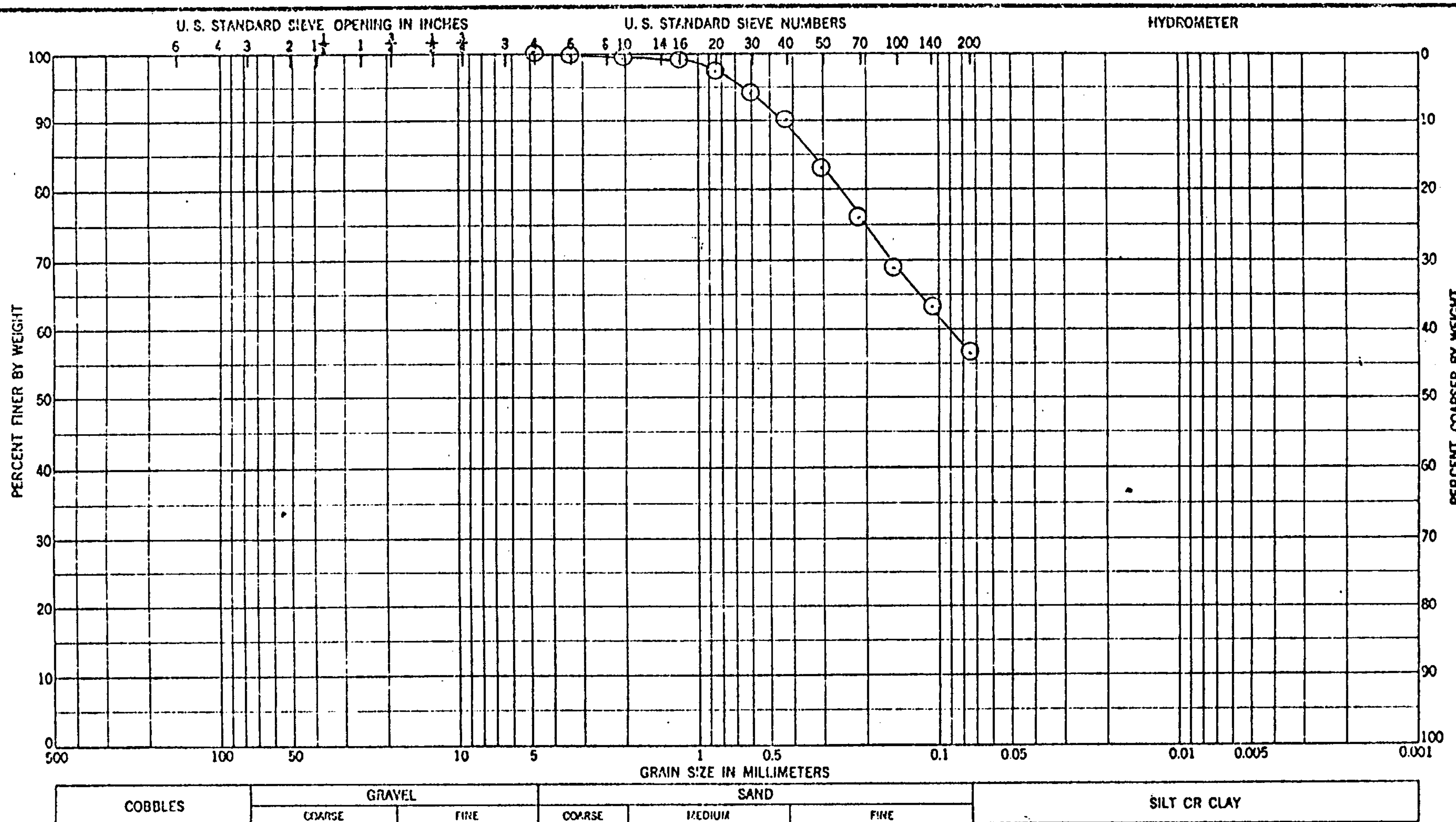
Boring No. D-6

Date 24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10} = 0.11
-200 = 8%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	SANDY CLAY(CL) Brown Gs=1.67(est)	14.9	36	15	21

Project ROCKY MOUNTAIN ARSENAL

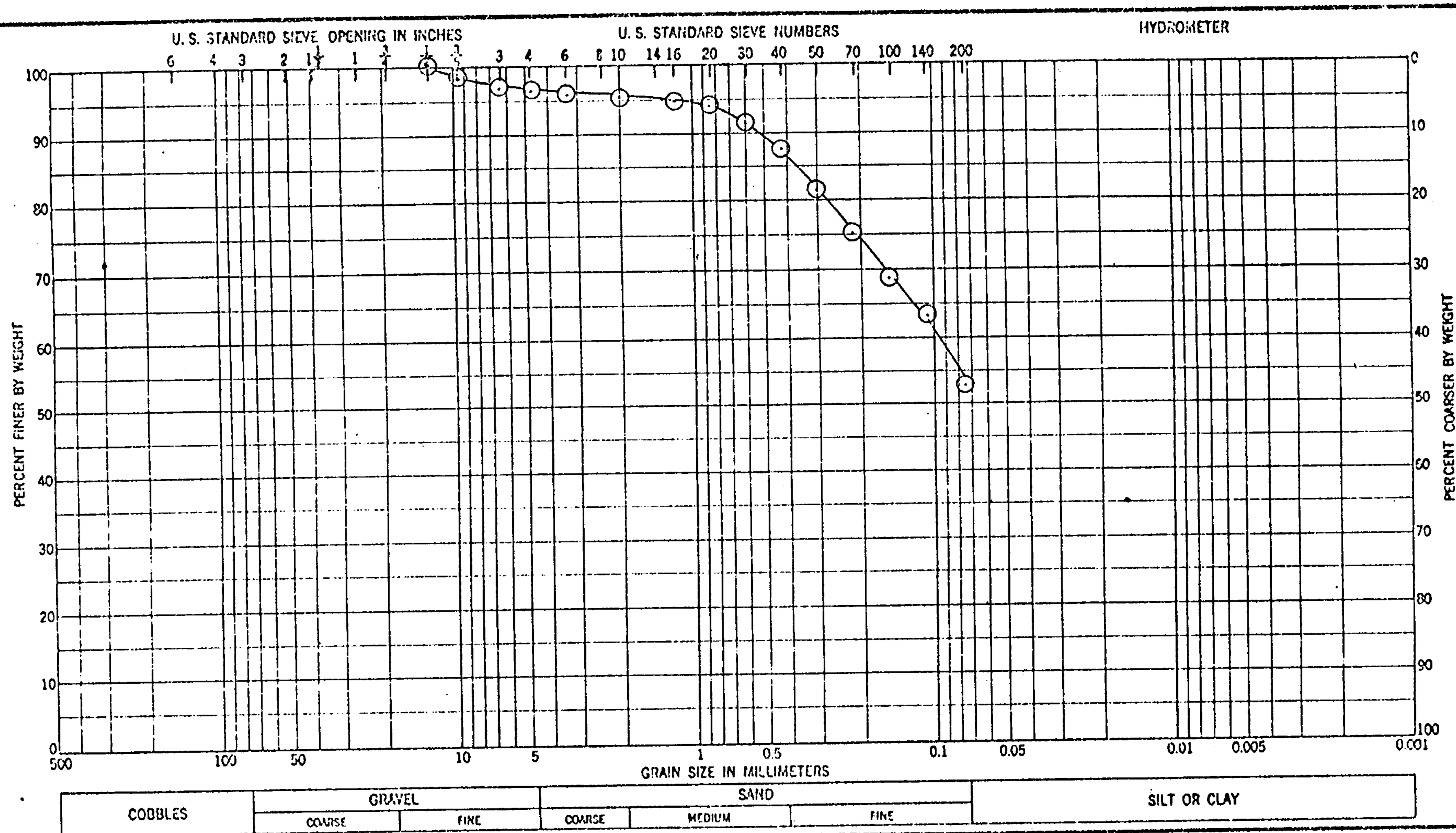
Area DEWATERING

Boring No. D-7

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SANDY CLAY(CL)	22.7	26	14	12
		With Trace Gravel				
		Light Brown				
		Gs=2.67(est)				

GRADATION CURVES

Project ROCKY MOUNTAIN ARSENAL

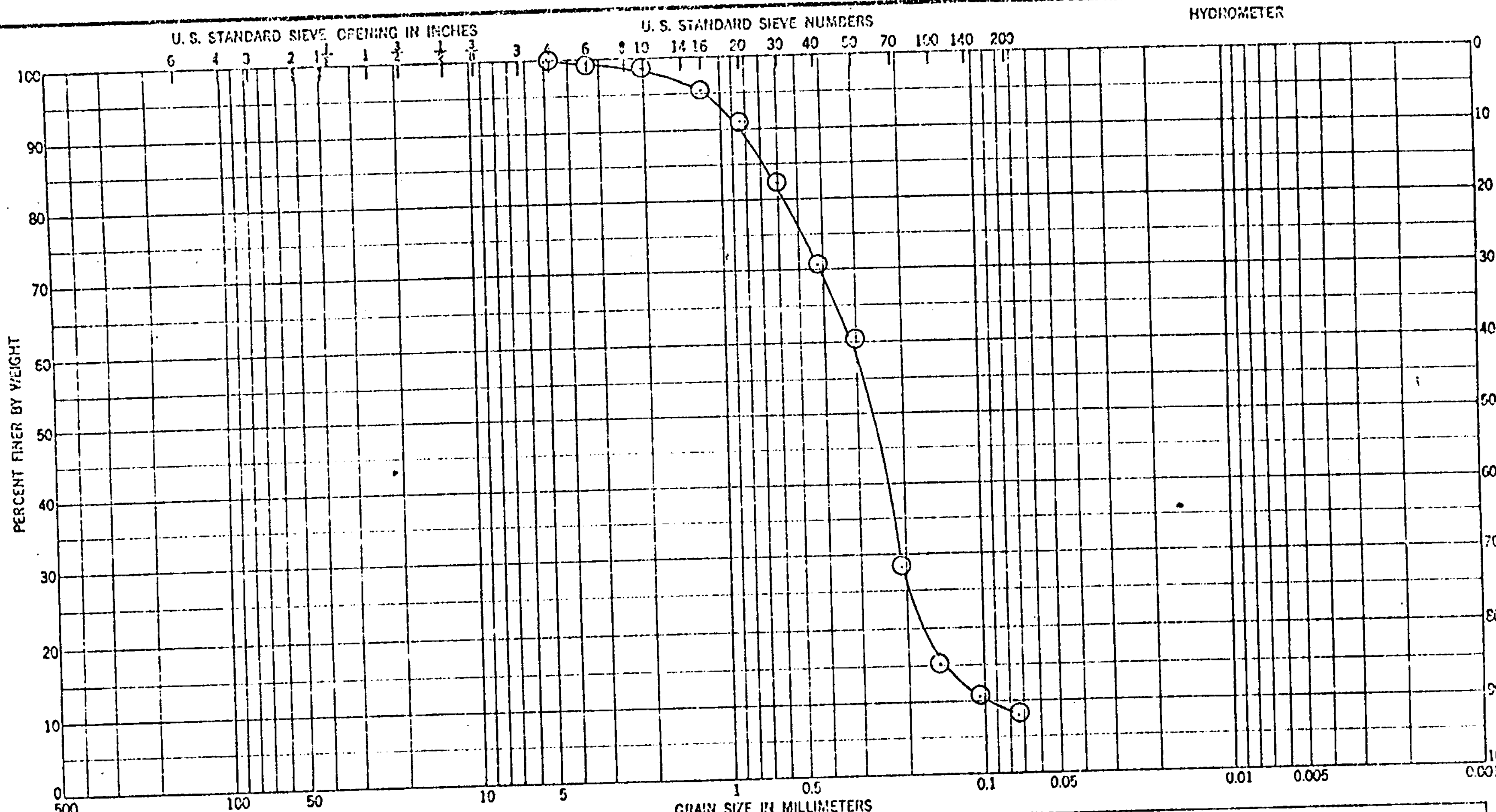
Area DEWATERING

Boring No. D-7

Date 23 August, 1976

ENG FORM 1 MAY 63 2087

PLATE 45



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND (SP-SM)	20.3	NP		
		Light Brown				
		Gs= 2.65(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

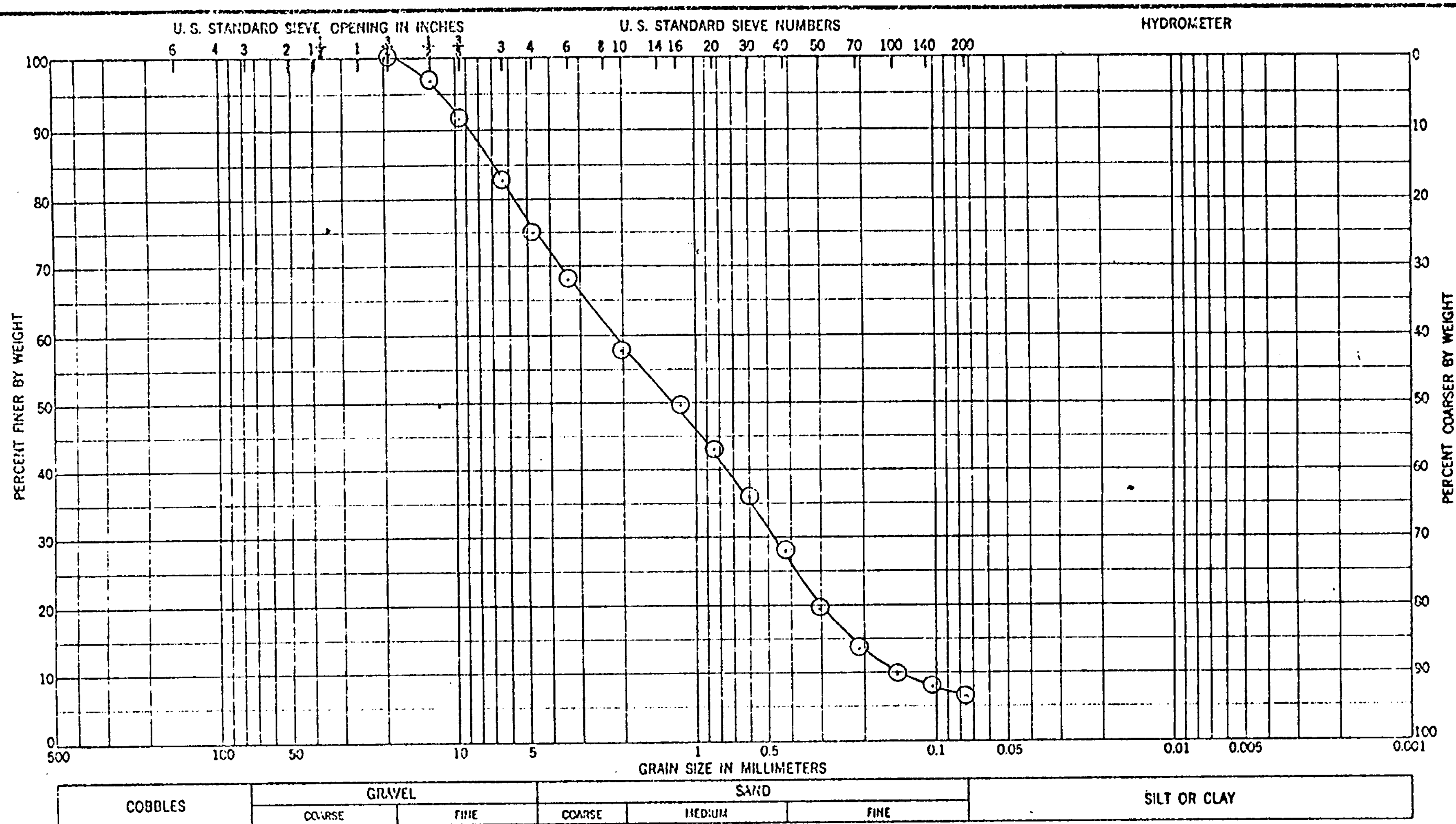
Boring No. D-7

Date 23 August, 1976

GRADATION CURVES

Ag. D_{10} = 0.095
-200 = 8%

ENG FORM 1 MAY 63 2087



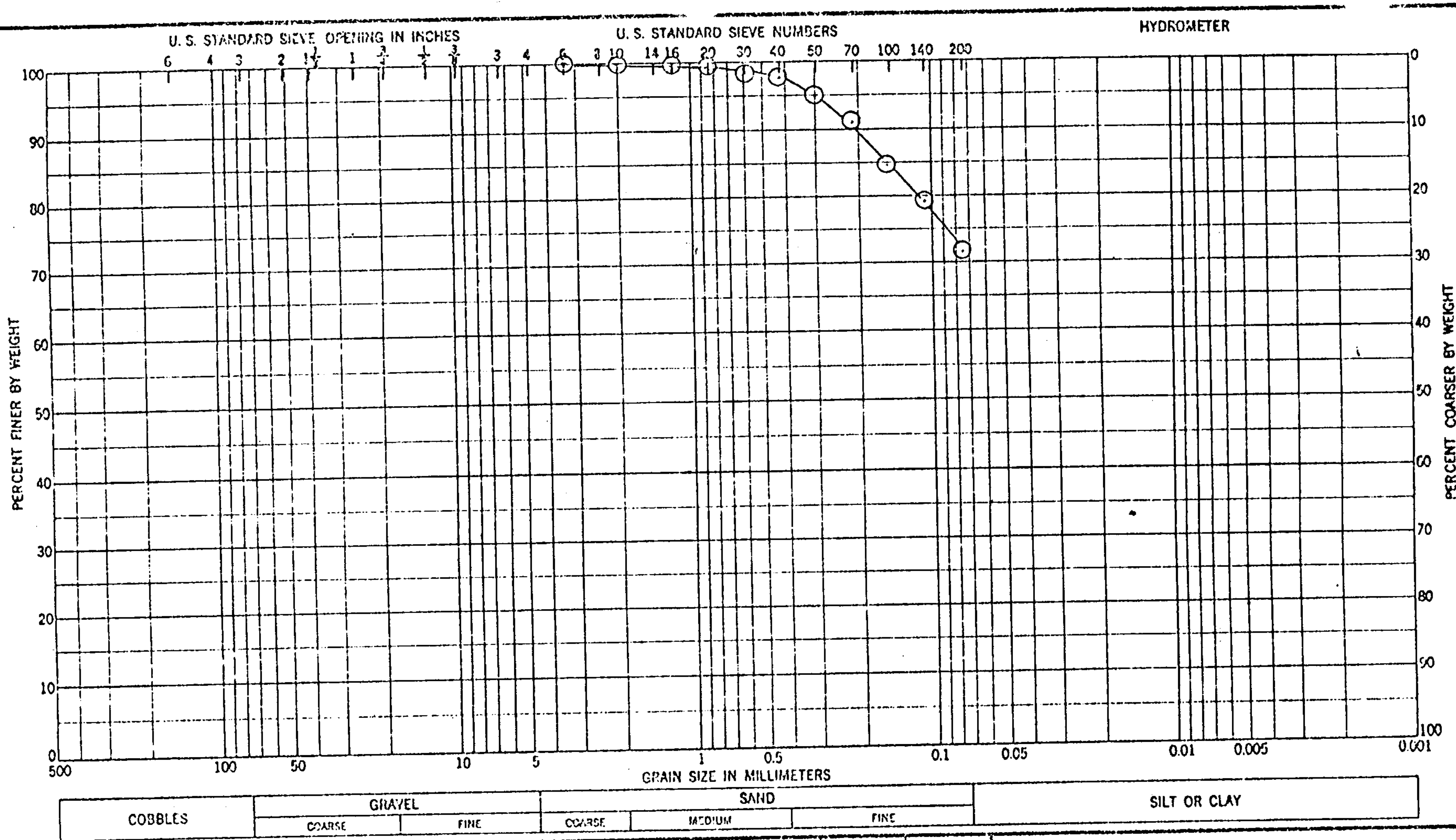
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20.0-21.5	GRAVELLY SAND(SP-SM) Brown Gs= 2.65(est)	15.6	NP		

Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	D-7
Date	23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. $D_{10} = 0.15$
-200 7%.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	25.0-26.5	CLAYEY, SANDY SILT(MH) Brown Gs= 2.70(est)	35.7	55	41	14

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

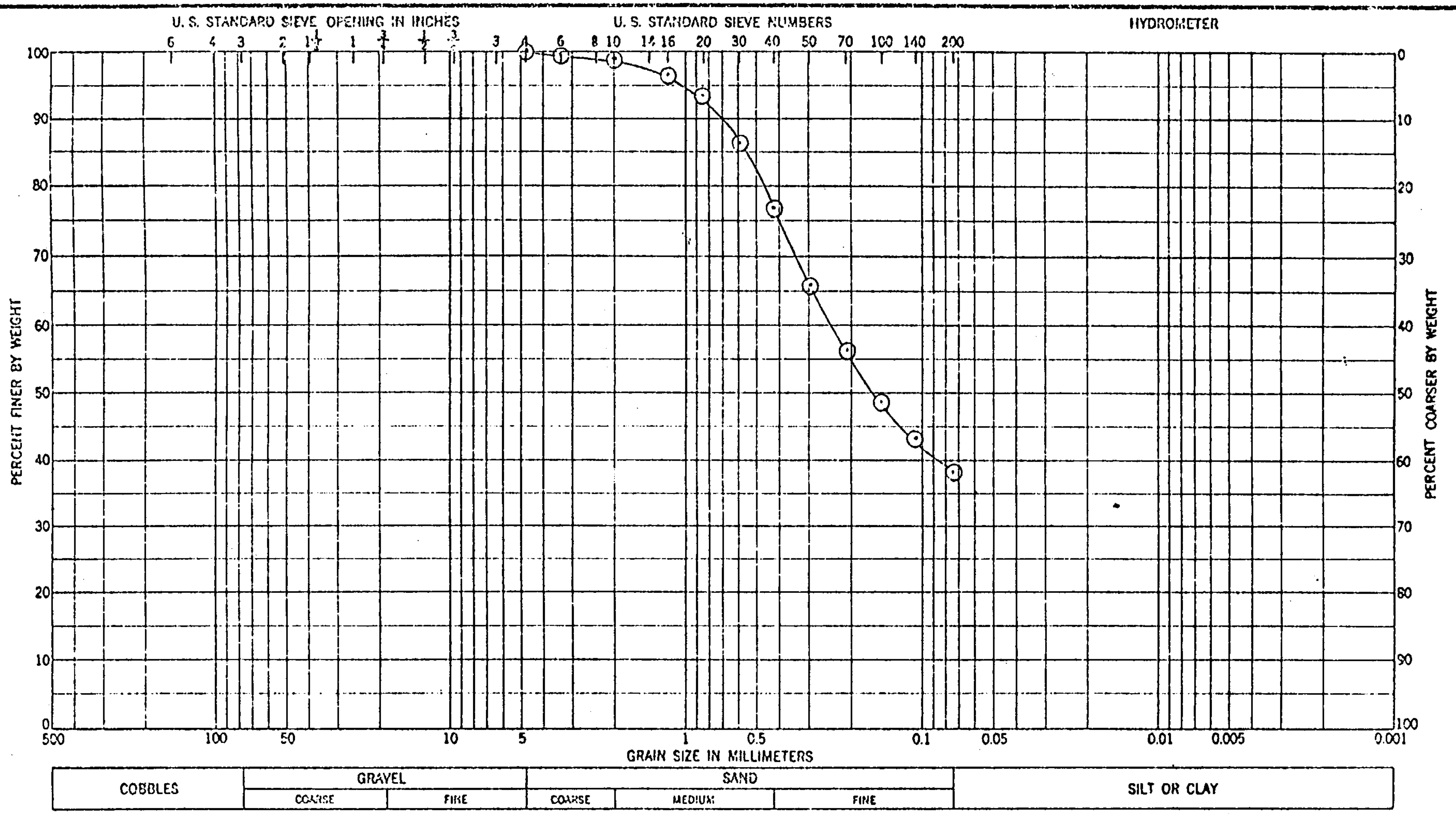
Boring No. D-7

Date 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 46



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-6.5	CLAYEY SAND(SC) Brown Gs= 2.66(est)	23.1	26	13	13

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

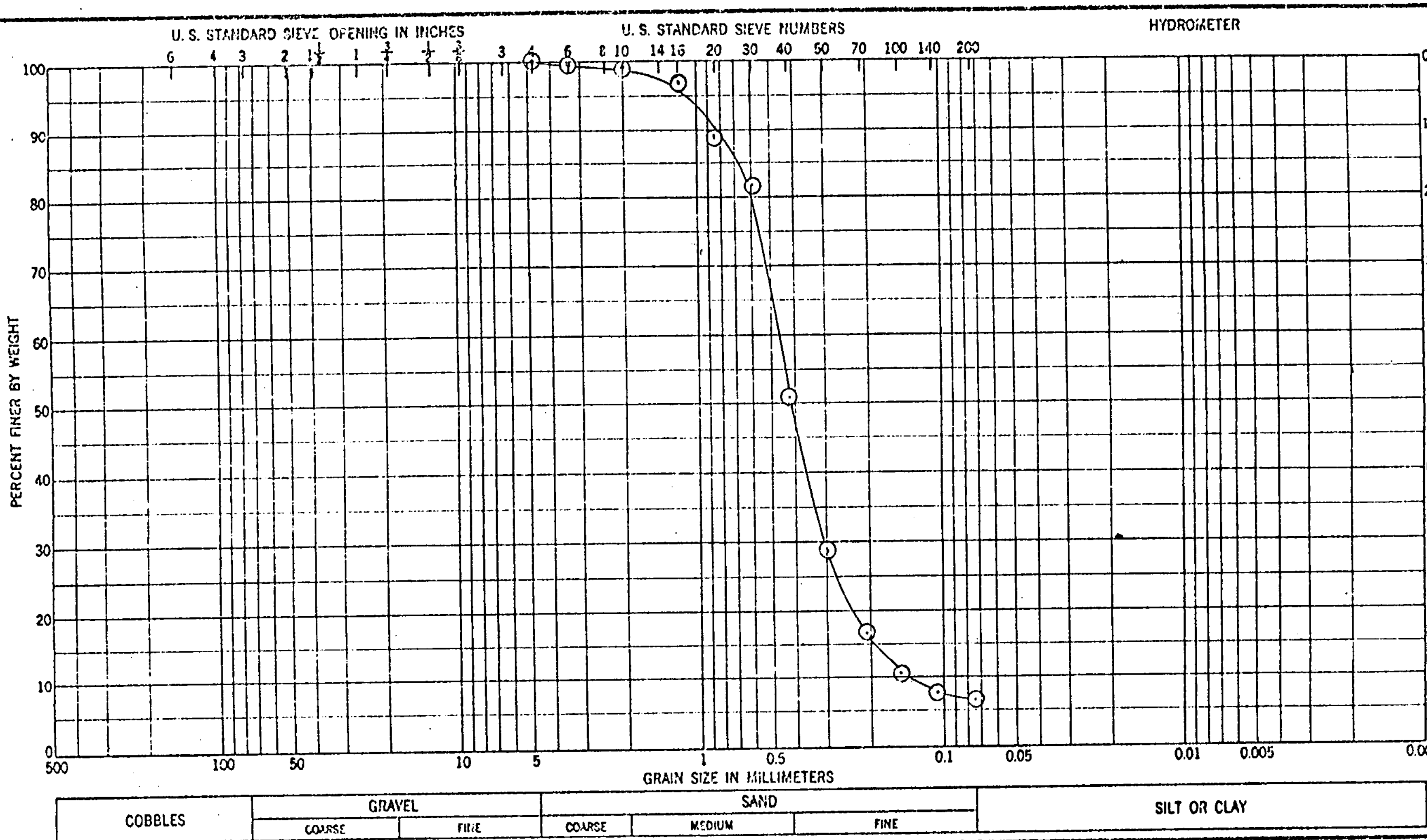
Boring No. D-8

Date 24 August, 1976

GRADATION CURVES

PLATE 49

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SAND(SP-SM)	21.3	NP		
		Tan				
		Gs= 2.66(est)				

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

Boring No. D-8

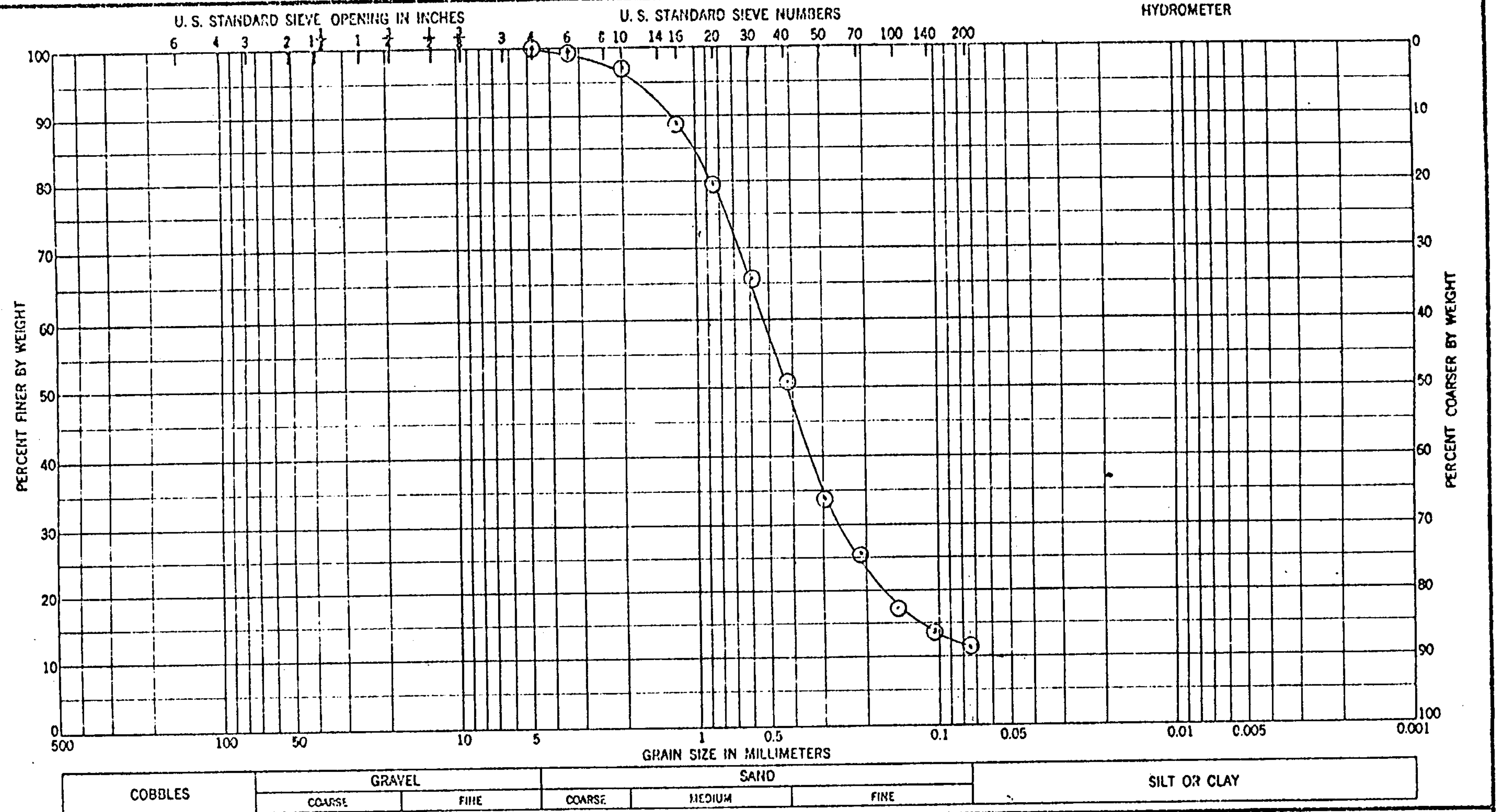
Date 24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10} = 0.14

-200 = 7%



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND(SP-SM)	16.8	NP		
		Brown				
		Gs= 2.66(est)				

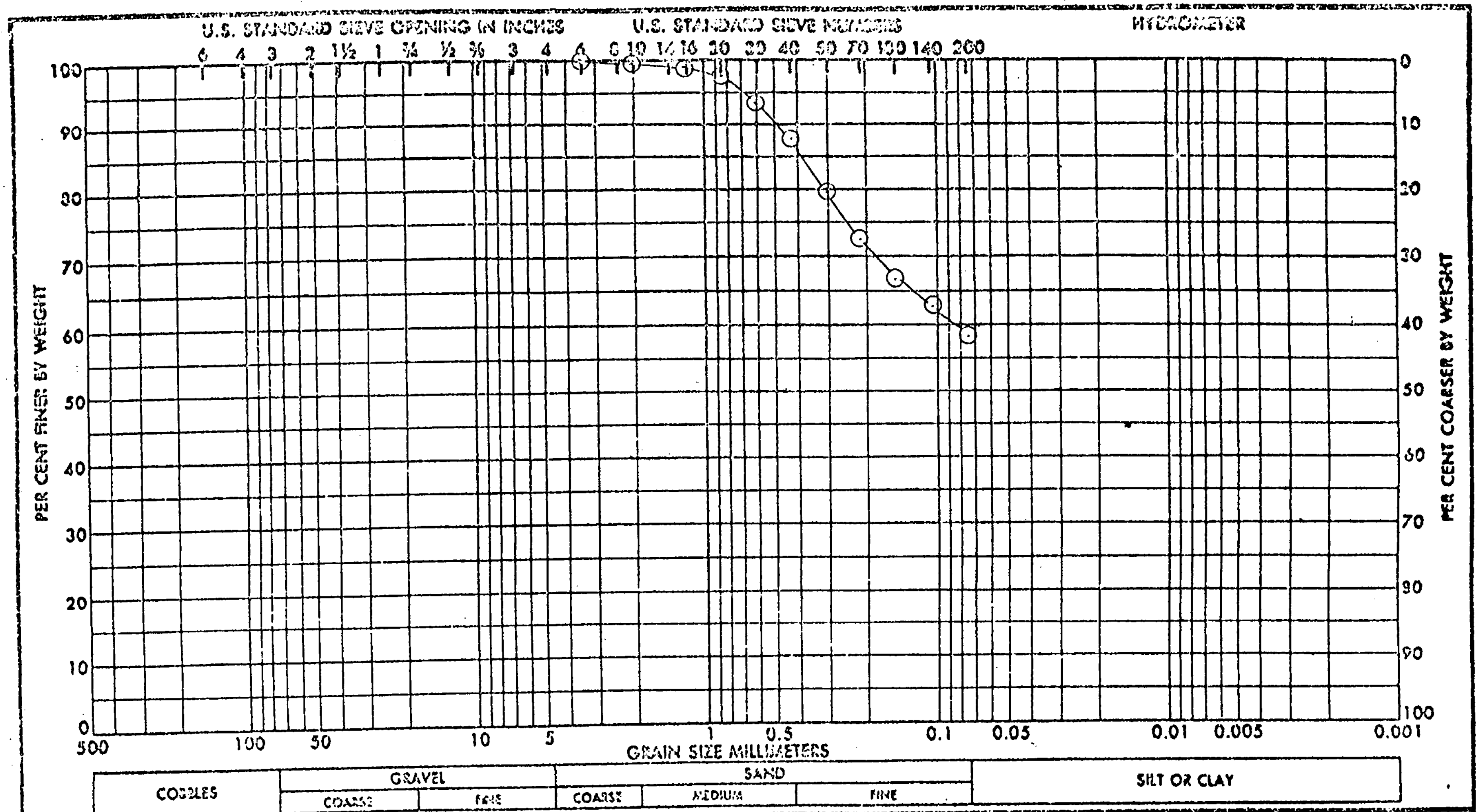
Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	D-8
Date	24 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag D_{10} : less than -200

-200 : 12%



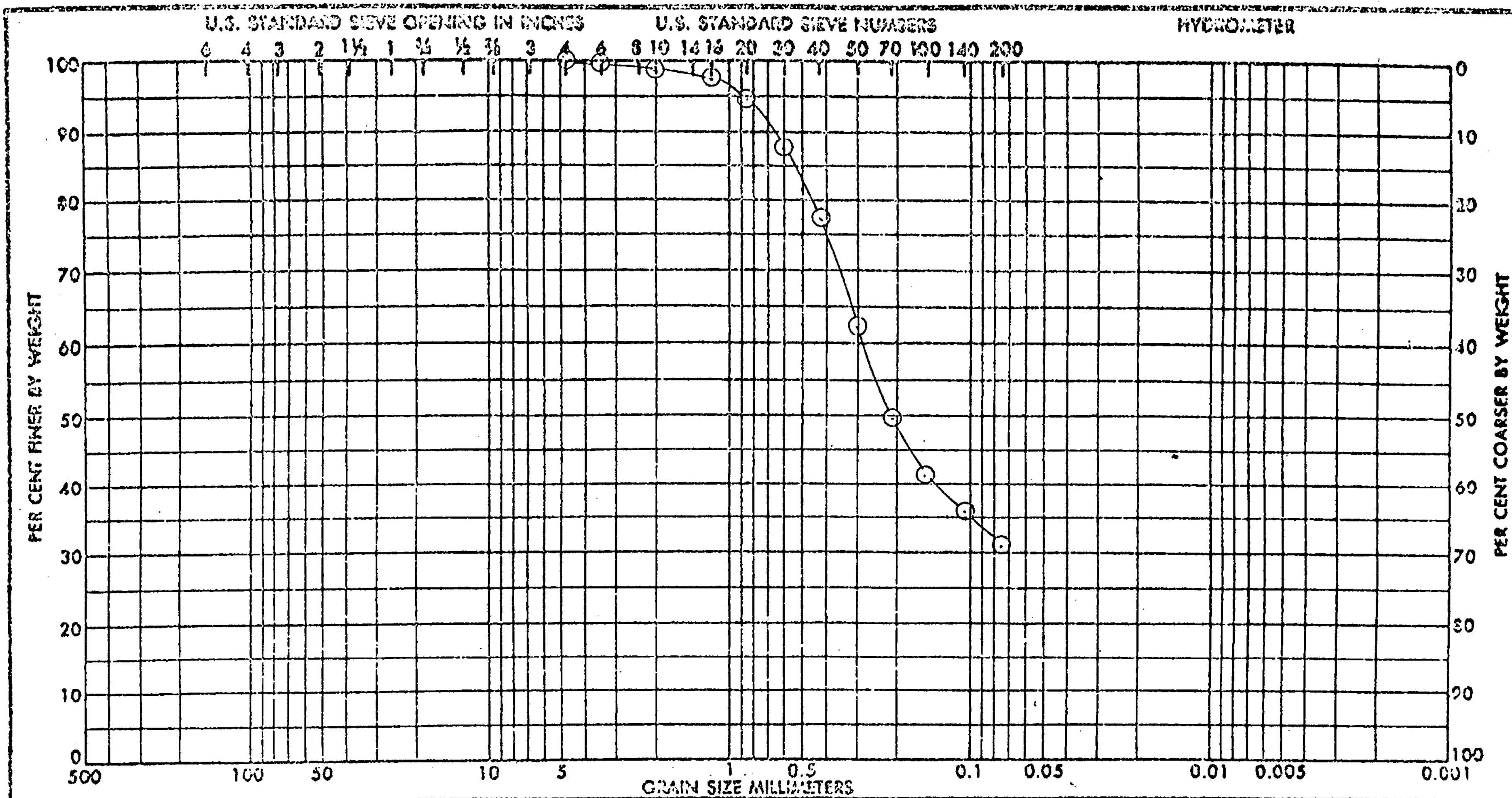
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1	0 - 1.5	SANDY CLAY (CL)		29	14	15
		Brown				
		Gs= 2.70				

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	
BORING NO.	UD-1
DATE	23 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	5.0-6.5	SILTY SAND (SM)	14.6	22	16	6
From Density		Grayish Brown				
		Gs=2.66(est)				

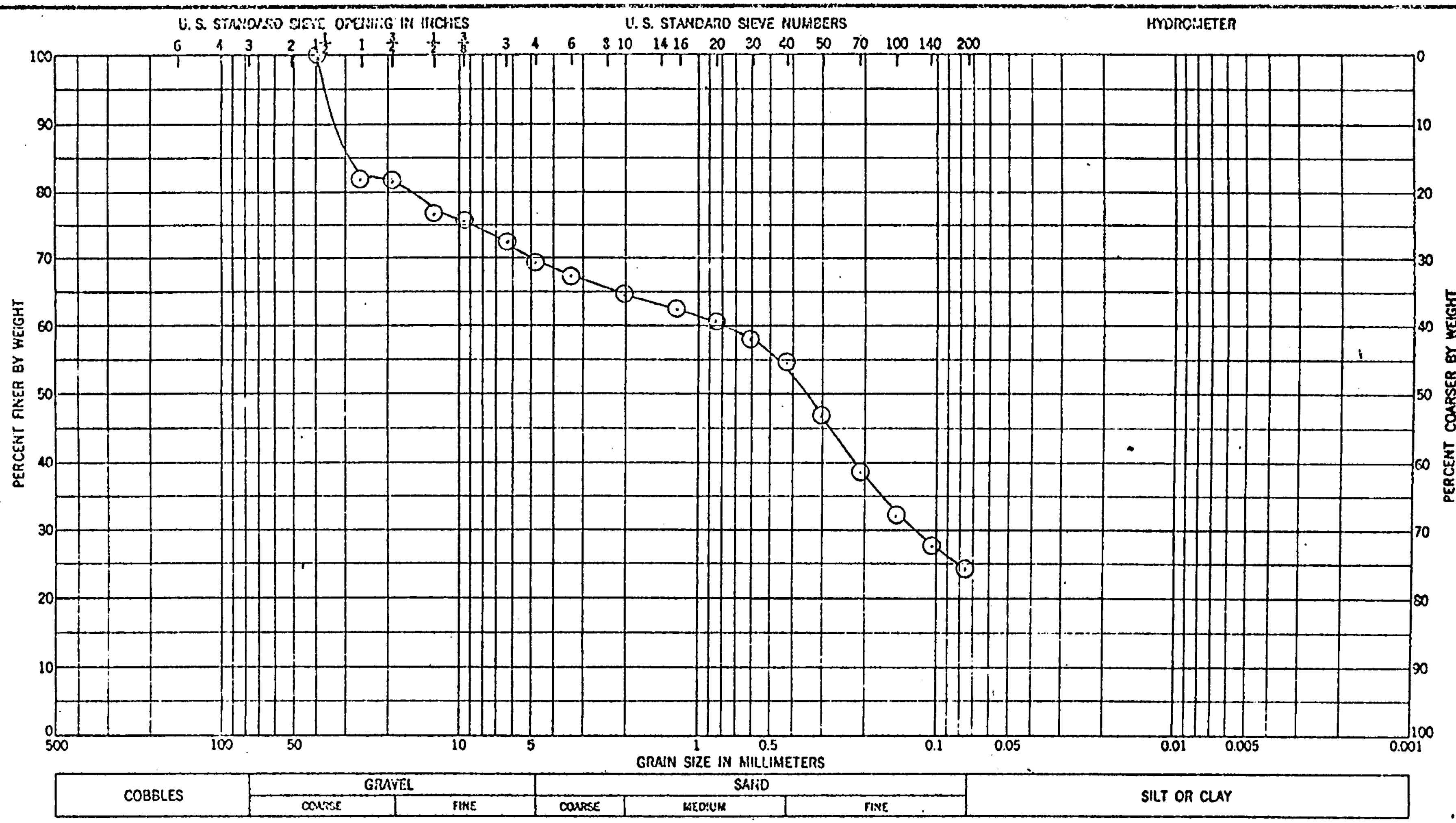
PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-1
DATE	3 Sept., 1976

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O7—709-128



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-11.5	SILTY, GRAVELLY SAND (SM)	19.0	23	18	5
		Brown				
		Gs= 2.66(est)				
Sample too small for representative gradation						

GRADATION CURVES

Project ROCKY MOUNTAIN ARSENAL

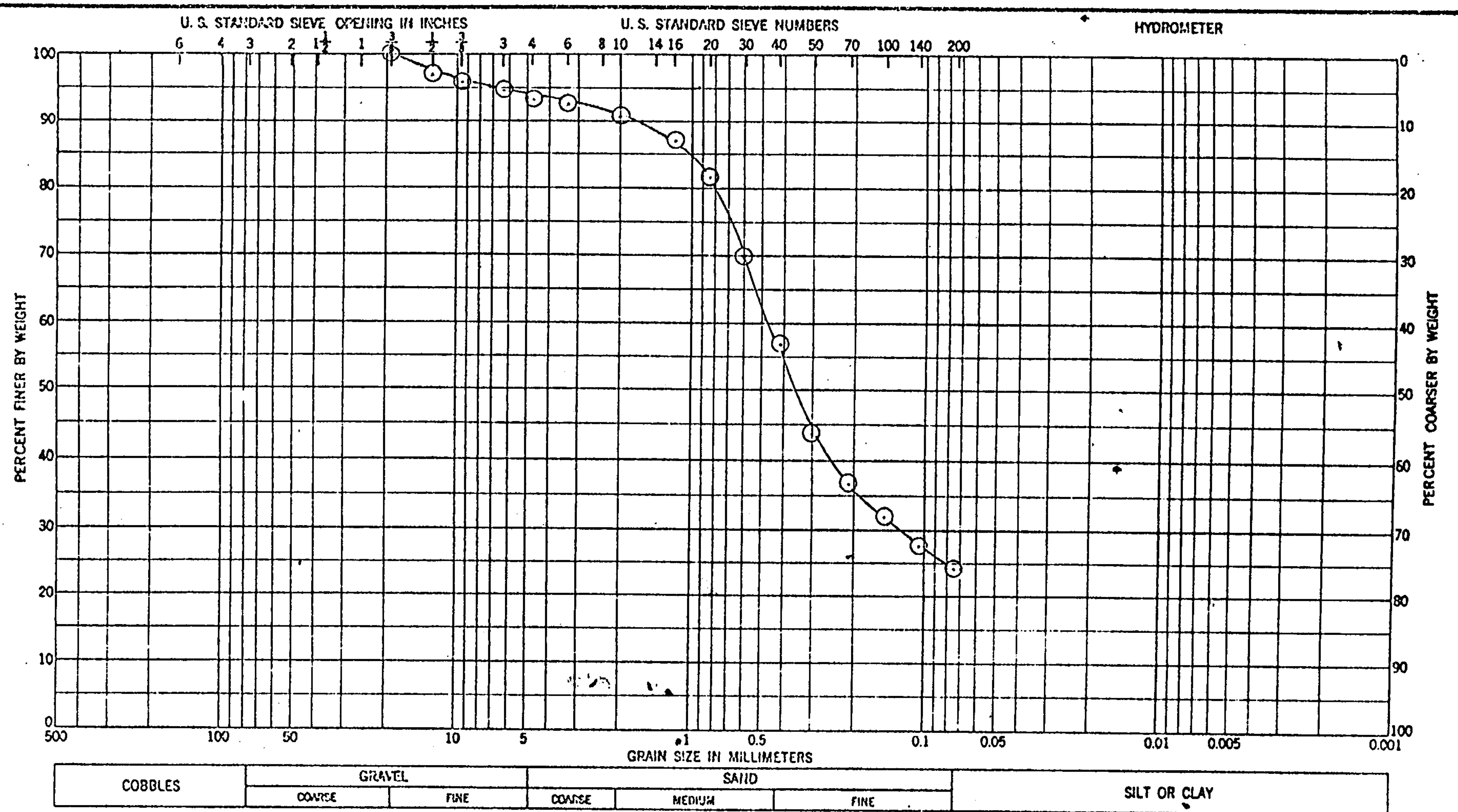
Area DEWATERING

Boring No. UD-1

Date 2 Sept., 1976

PLATE 54

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	CLAYEY SAND(SC) With Gravel Brown Gs= 2.66(est)	16.7	25	17	8

Project: ROCKY MOUNTAIN ARSENAL

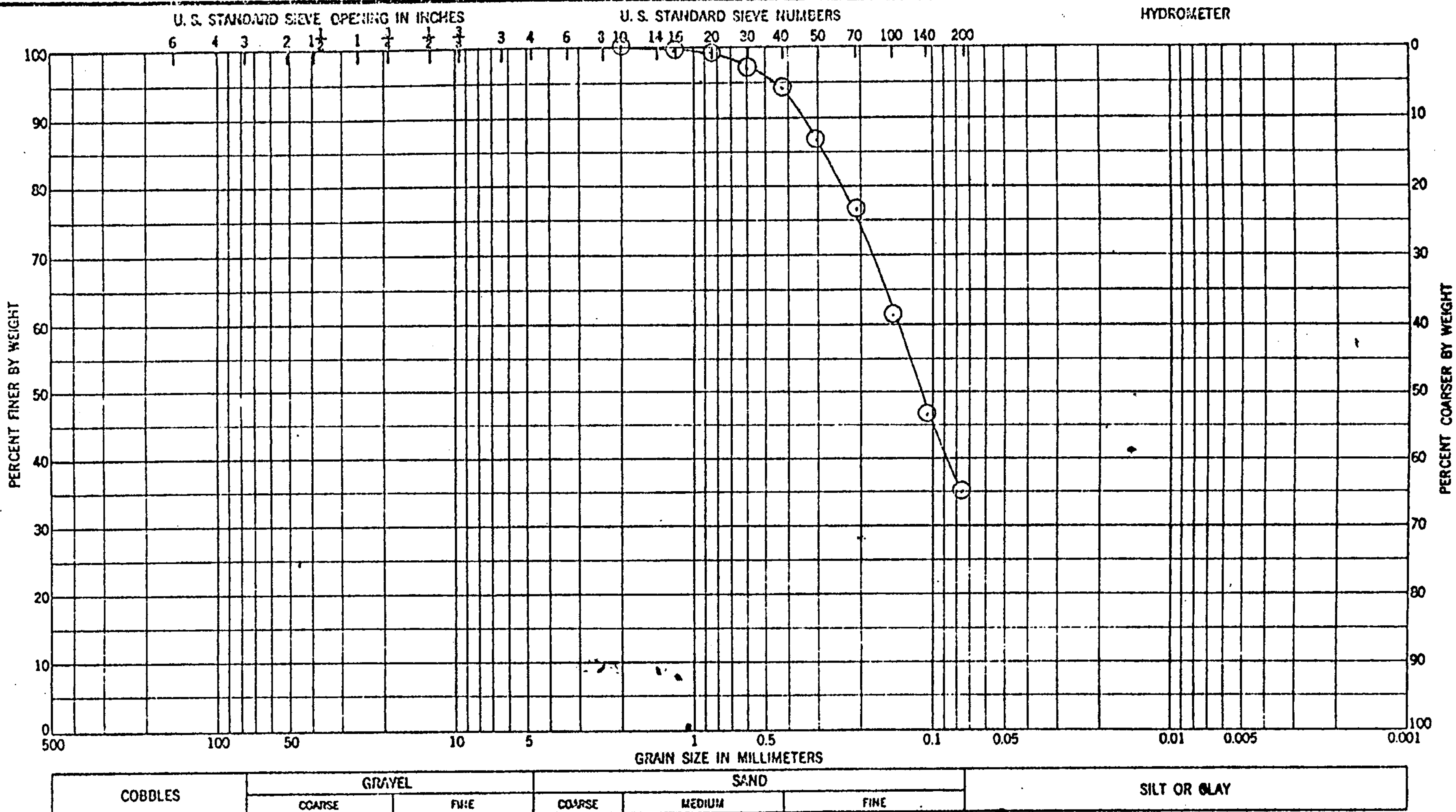
Area: DEWATERING

Boring No.: UD-1

Date: 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20-21.5	CLAYEY, SILTY SAND(SM)	31.6	54	38	16
		Brown				
		Gs= 2.69(est)				

Project: ROCKY MOUNTAIN ARSENAL

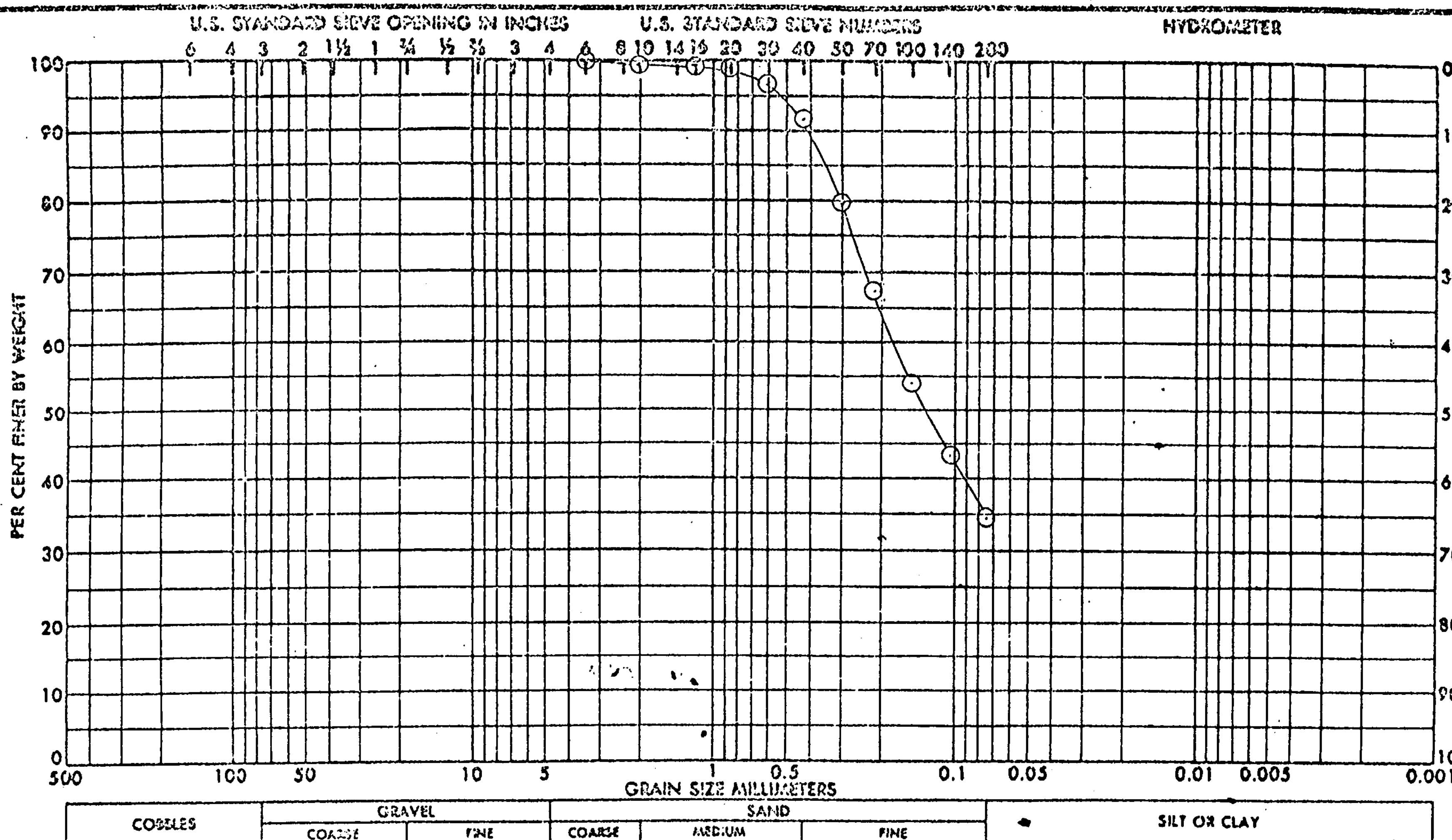
Area: DEWATERING

Boring No. UD-1

Date: 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1		SILTY SAND(SM)		NP	-	
		Brown				
		Gs= 2.70				

PROJECT ROCKY MOUNTAIN ARSENAL

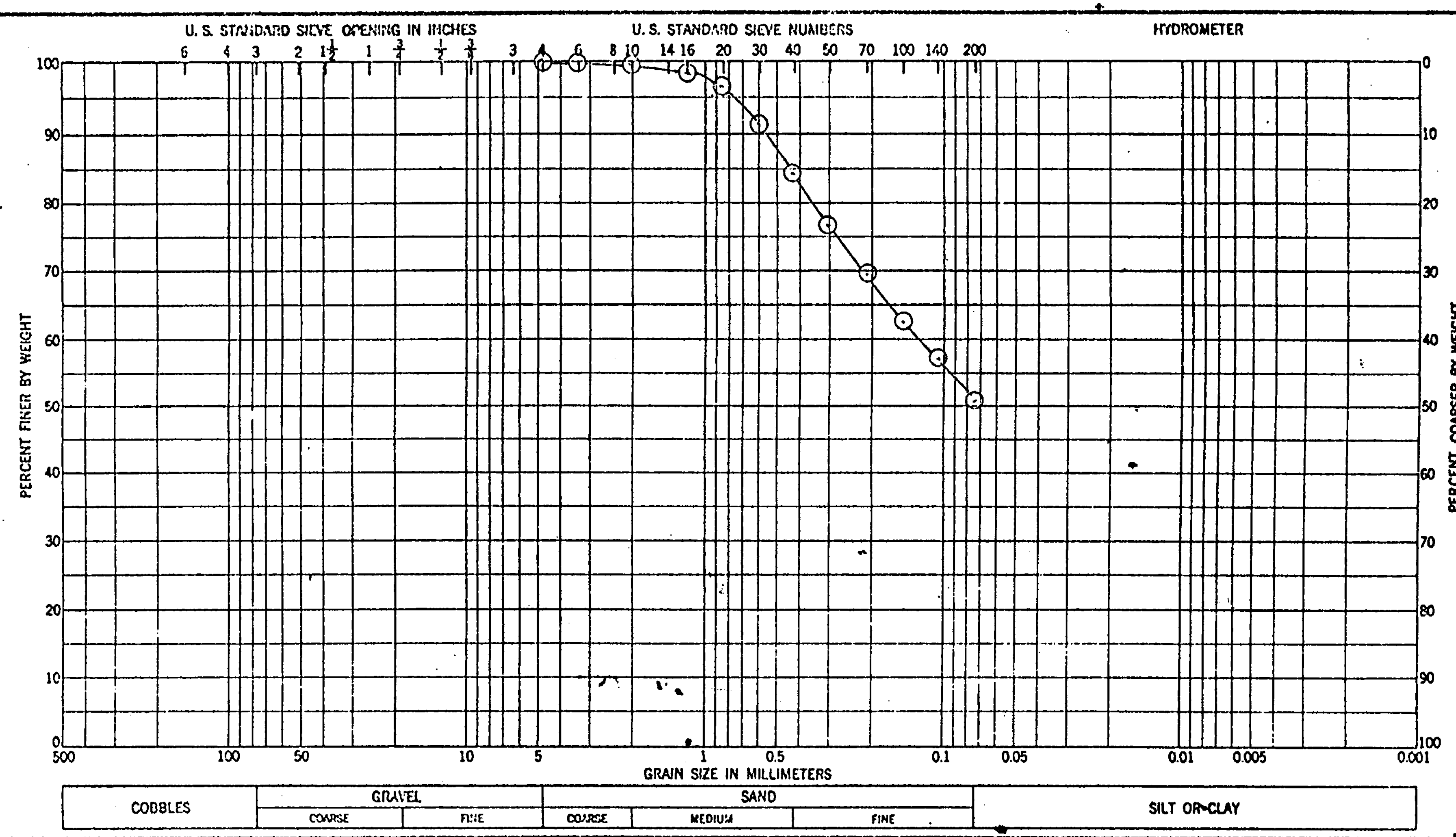
AREA

BORING NO. UD-2

DATE 23 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SANDY CLAY(CL) Brown Gs= 2.67(est)	26.5	30	15	15

Project: ROCKY MOUNTAIN ARSENAL

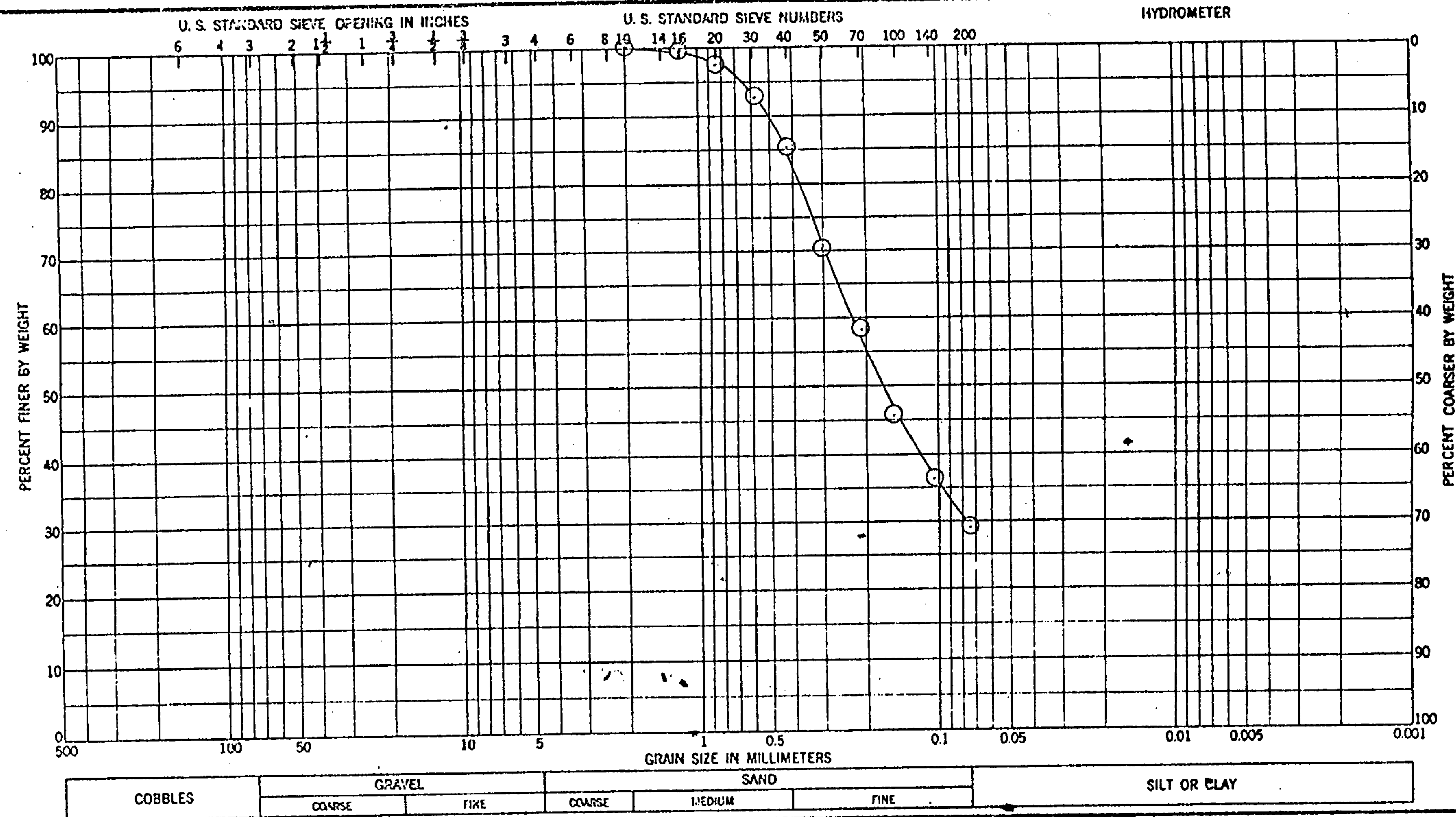
Area: DEWATERING

Boring No.: UD-2

Date: 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

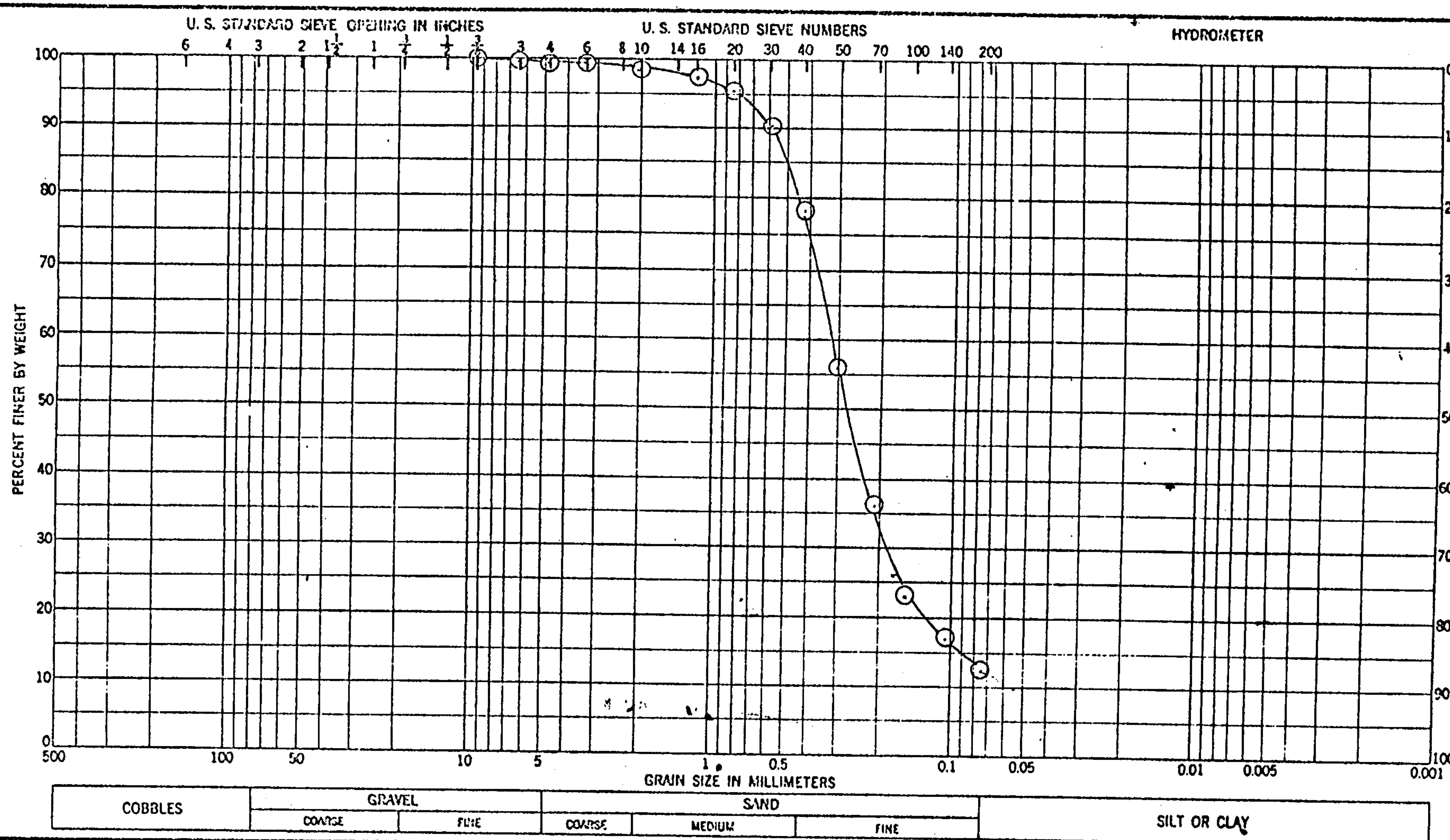


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20.0-21.5	CLAYEY, SILTY SAND(SM)	17.5	20	15	5
		Brown				
		Gs= 2.66(est)				

Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	UD-2
Date	3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	25.0-26.5	SILTY SAND(SM)	27.0	NP		
		Brown				
		Gs= 2.67(est)				

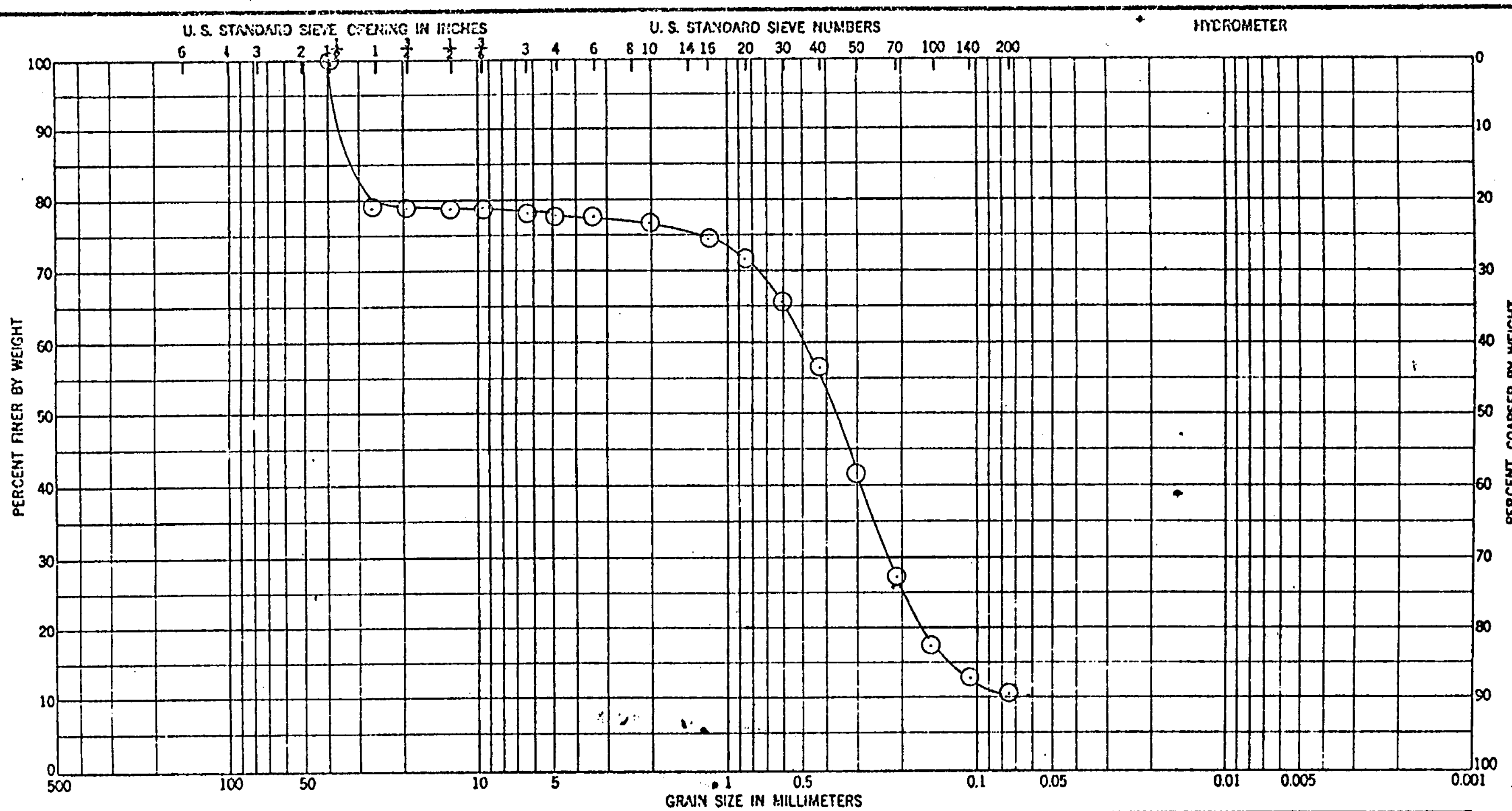
GRADATION CURVES

Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	UD- 2
Date	3-Sept., 1976

ENG FORM 1 MAY 63 2087

Av. D_{10} = less than 0.074m

-200 = 13%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
7	30.0-31.5	SAND(SP-SM)	16.7	NP		
		Brown				
		Gs= 2.65(est)				
Sample too small for representative gradation						

Project ROCKY MOUNTAIN ARSENAL

Area DEWATERING

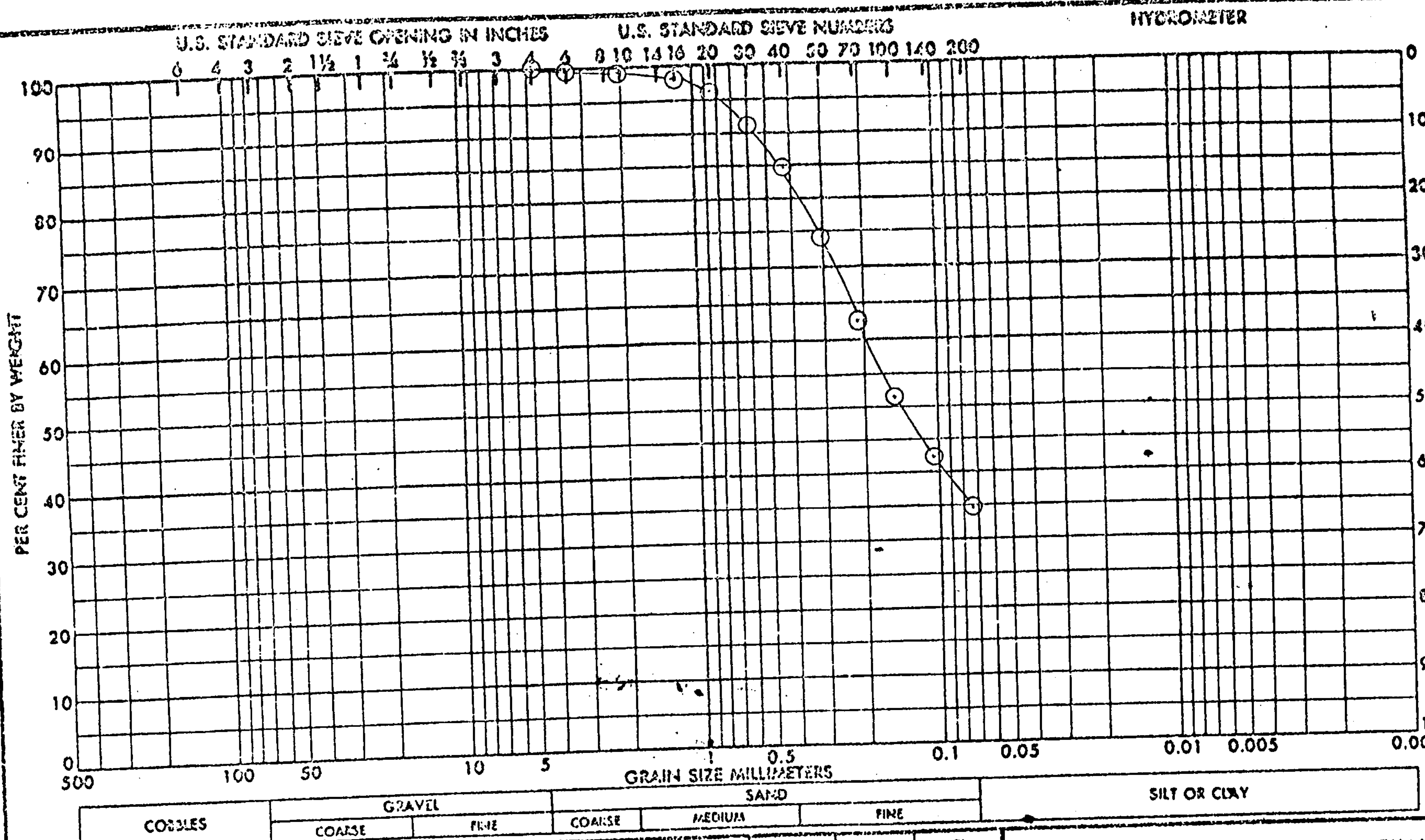
Boring No. UD-2

Date 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. D_{10} = less than 0.074 mm
-200% = 11%



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	5 - 6.5	SILTY SAND (SM)		20	17	3
		Dark Gray				
		Gs= 2.69				

PROJECT ROCKY MOUNTAIN ARSENAL

AREA

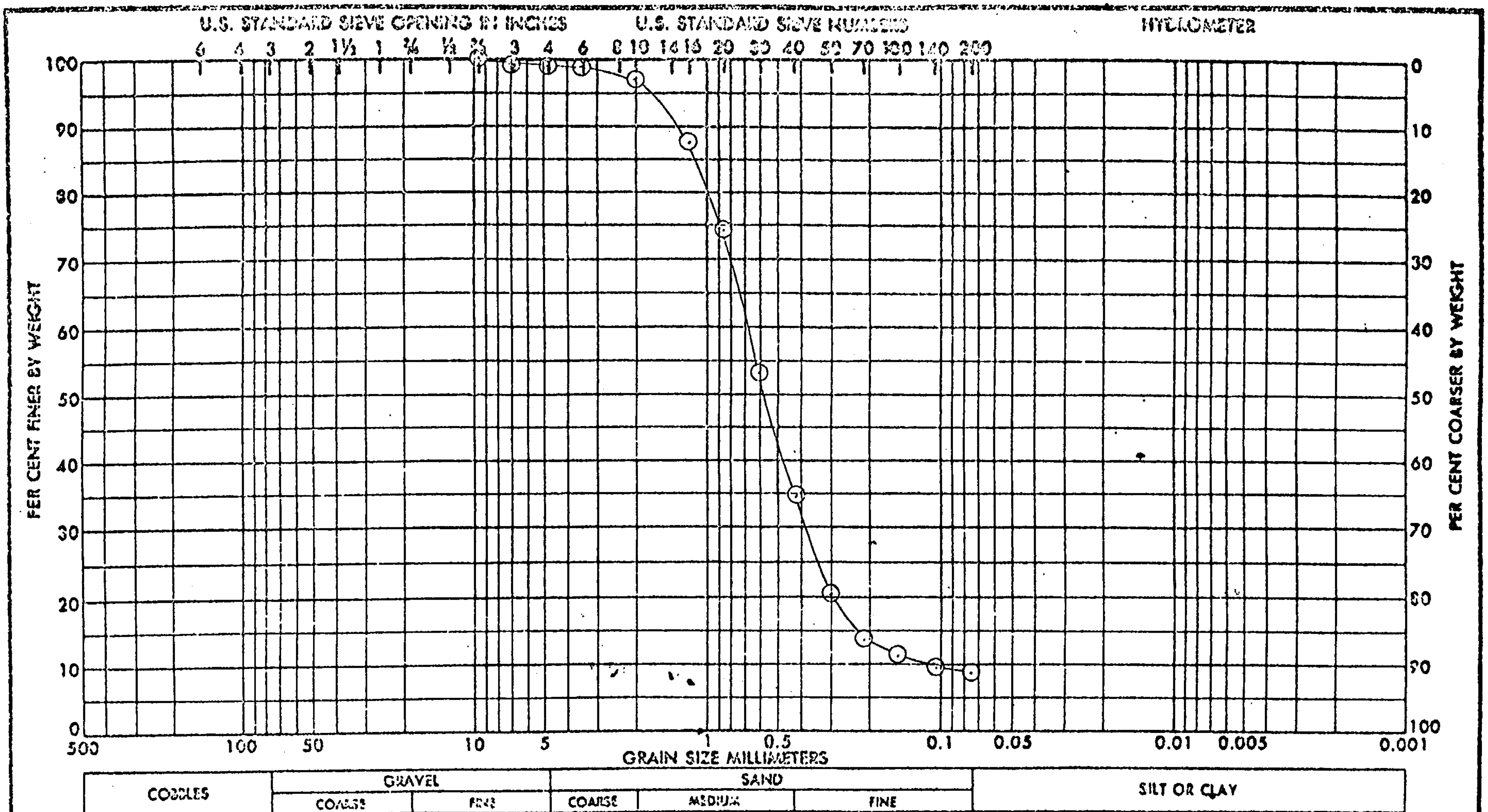
BORING NO. UD-3

DATE 23 Sept., 1976

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	10.0-11.5	SAND(SP-SM)	15.8	NP		
		Brown				
		Gs= 2.66(est)				

GRADATION CURVES

PROJECT: ROCKY MOUNTAIN ARSENAL

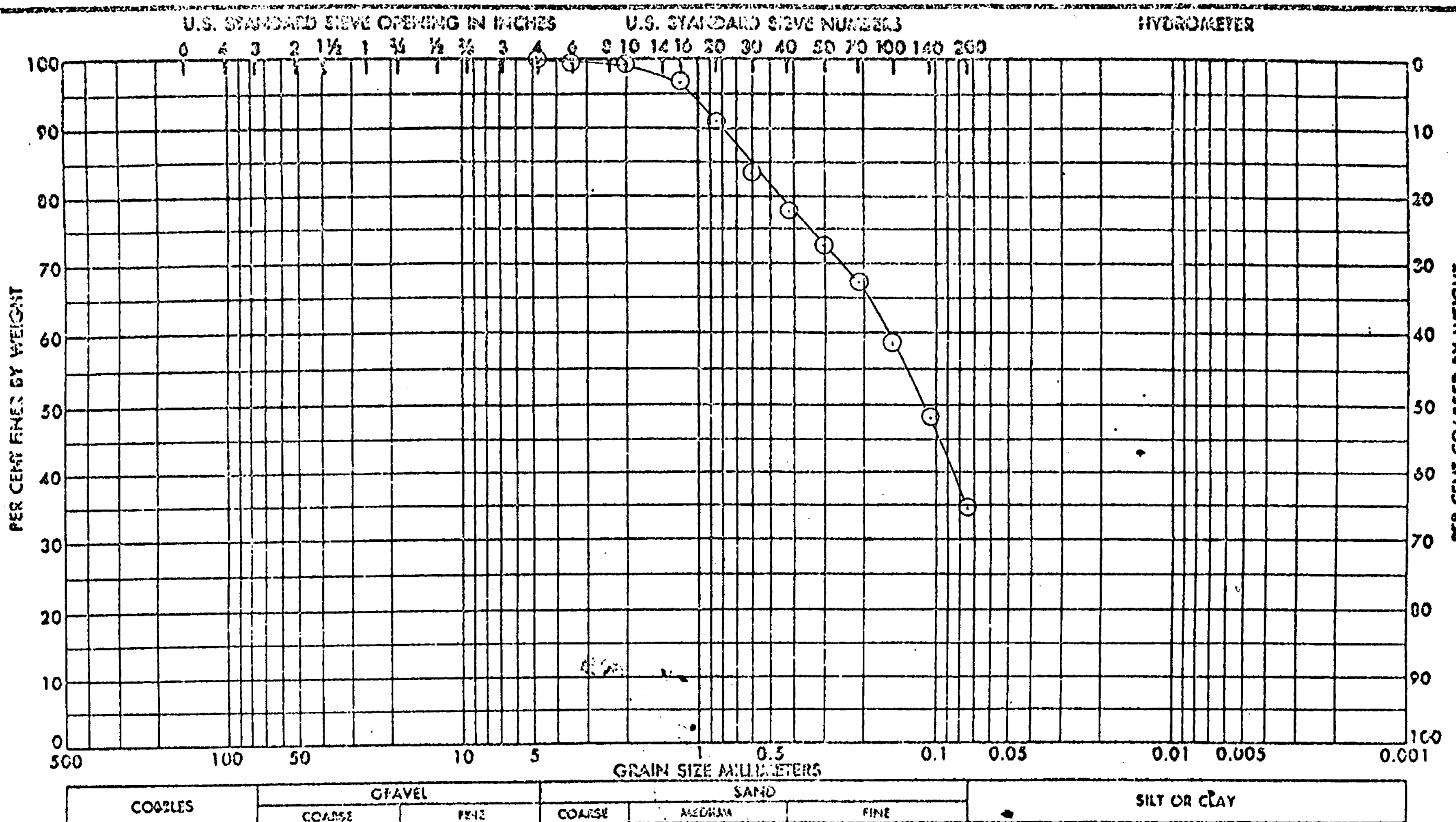
AREA: DEWATERING

BORING NO.: UD-3

DATE: 3 Sept.', 1976

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

Av. D_{10} = 0.10
-200 = 9%

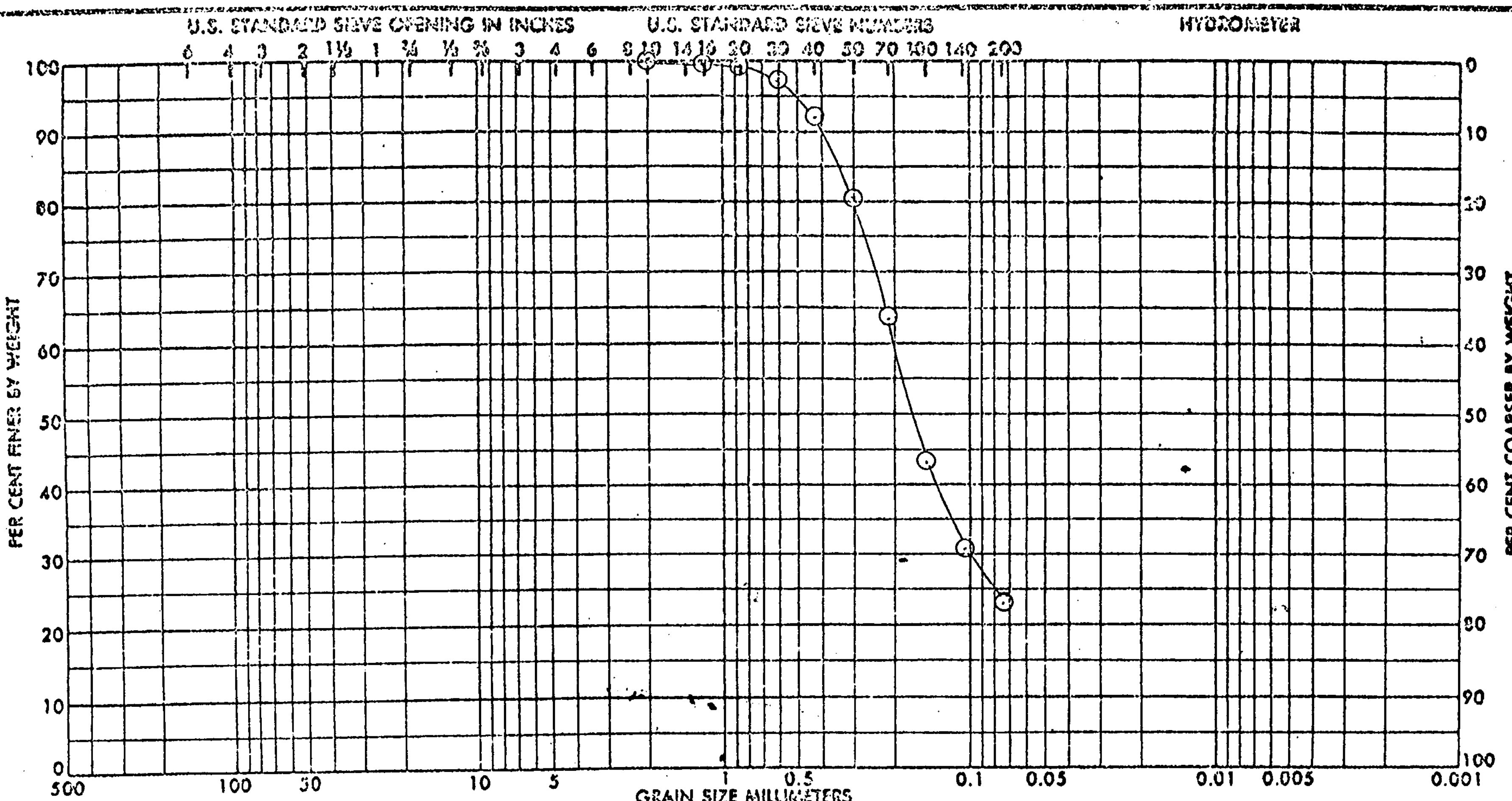


SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	~~20.0-21.5~~	SILTY SAND(SM)	32.5	57	40	17
	15.0 - 16.5	Brown				
		Gs= 2.70(est)				

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-3
DATE	3 Sept., 1976

GRADATION CURVES

ENG FORM 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.
1 MAY 63



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	20.0-21.5	SILTY SAND(SM)	24.3	44	34	10
		Brown				
		Gs= 2.66(est)				

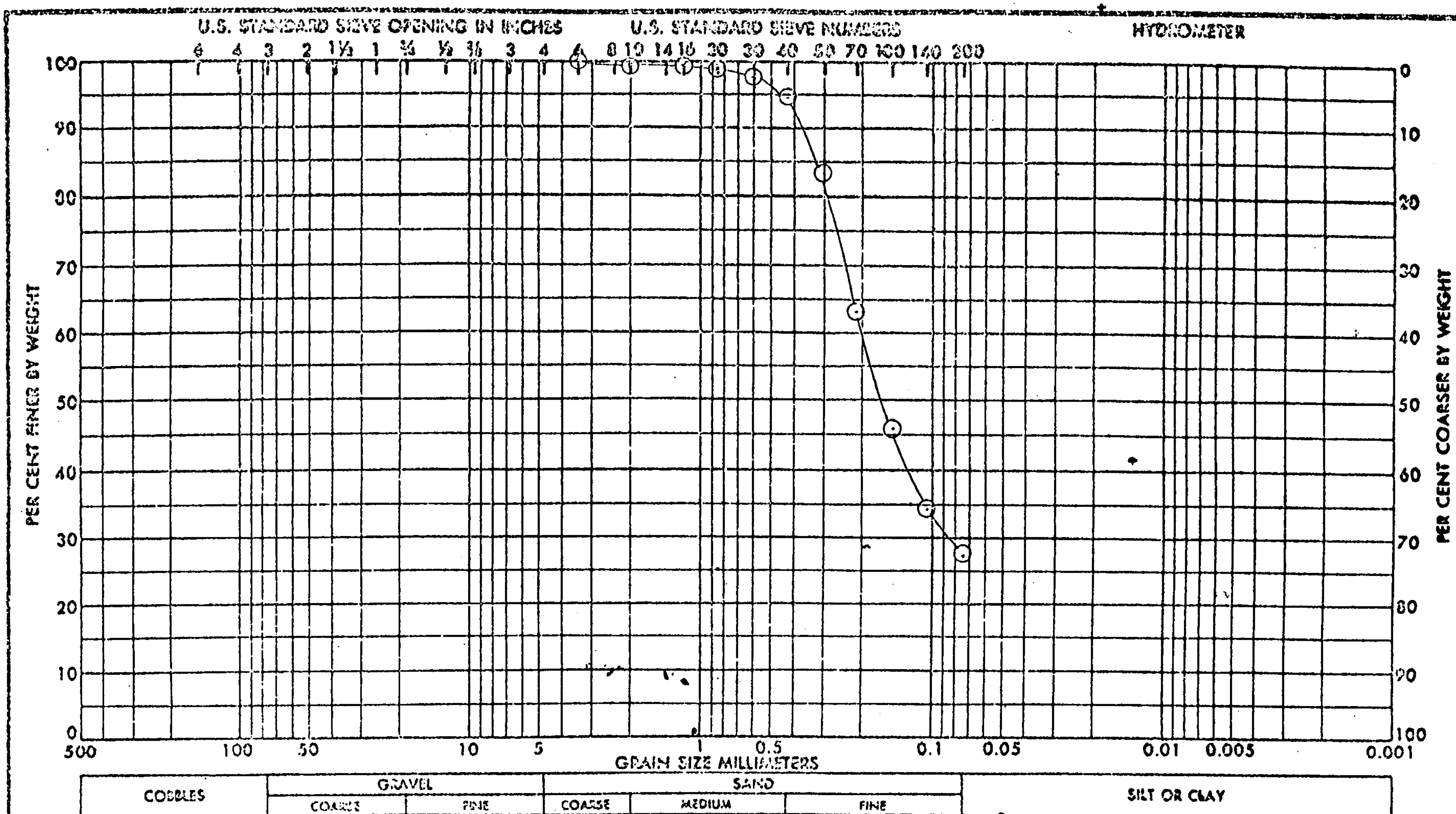
PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-3
DATE	3 Sept., 1976

GRADATION CURVES

U.S. GOVERNMENT PRINTING OFFICE

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
6	25.0-26.0	SILTY SAND(SM)	16.4	37	27	10
		Dark Gray				
		Gs =2.66(est)				

PROJECT: ROCKY MOUNTAIN ARSENAL

AREA: DEWATERING

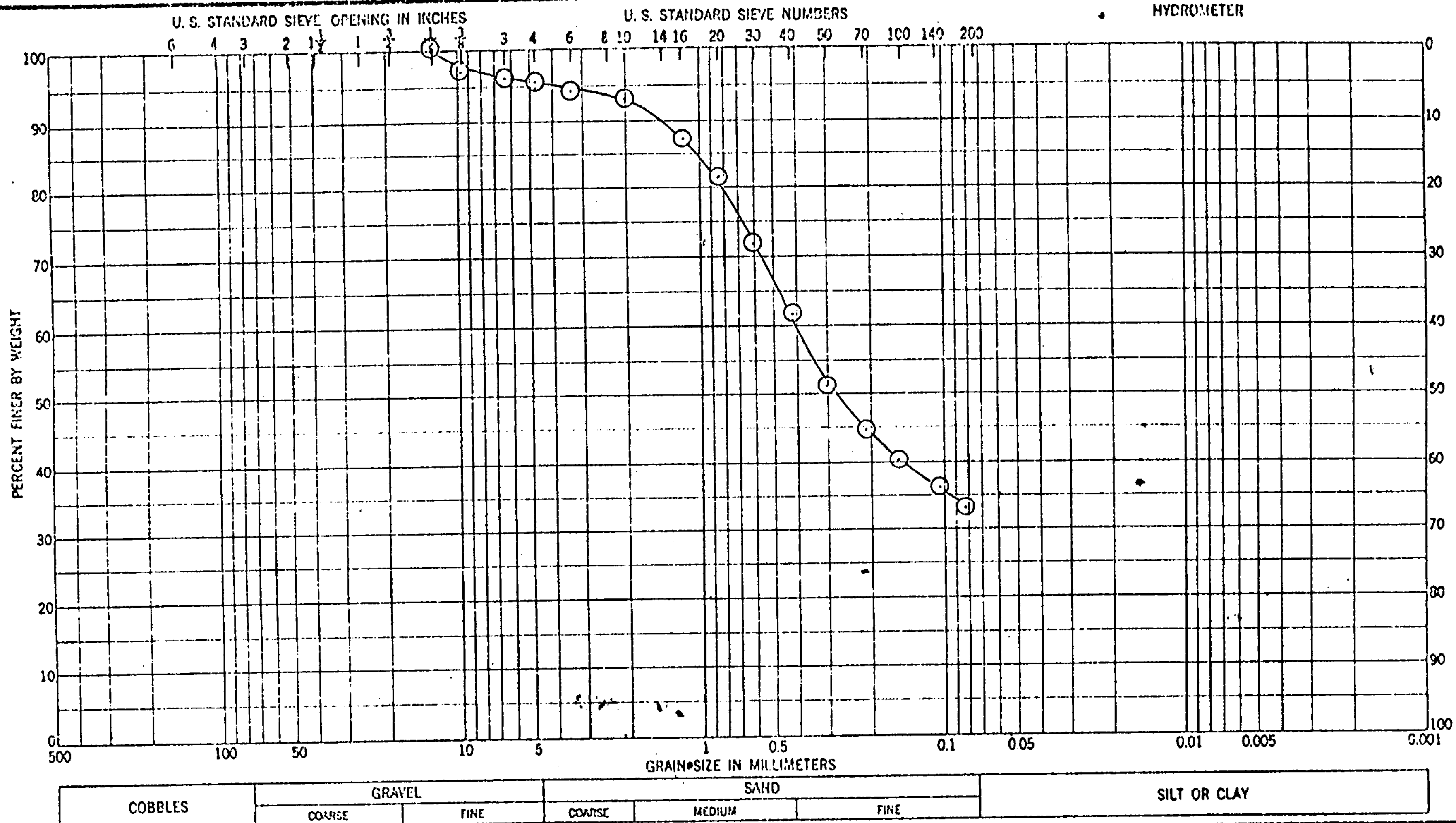
BORING NO. UD-3

DATE: 3 Sept., 1976

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND(SC)	25.5	52	22	30
		With Trace Gravel				
		Brownish Gray				
		Gs= 2.66(est)				

Project: ROCKY MOUNTAIN ARSENAL

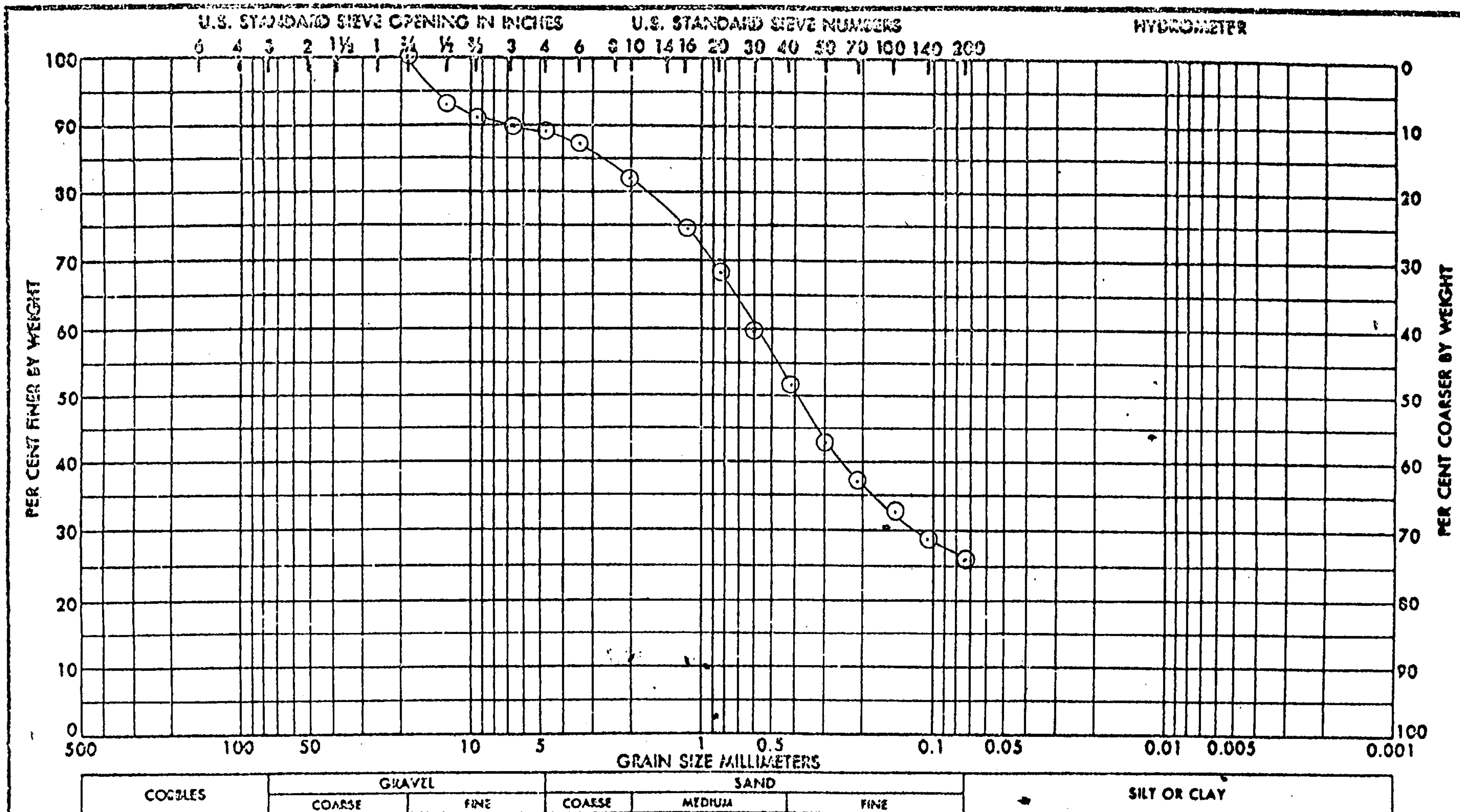
Area: DEWATERING

Boring No. UD-4

Date: 23 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



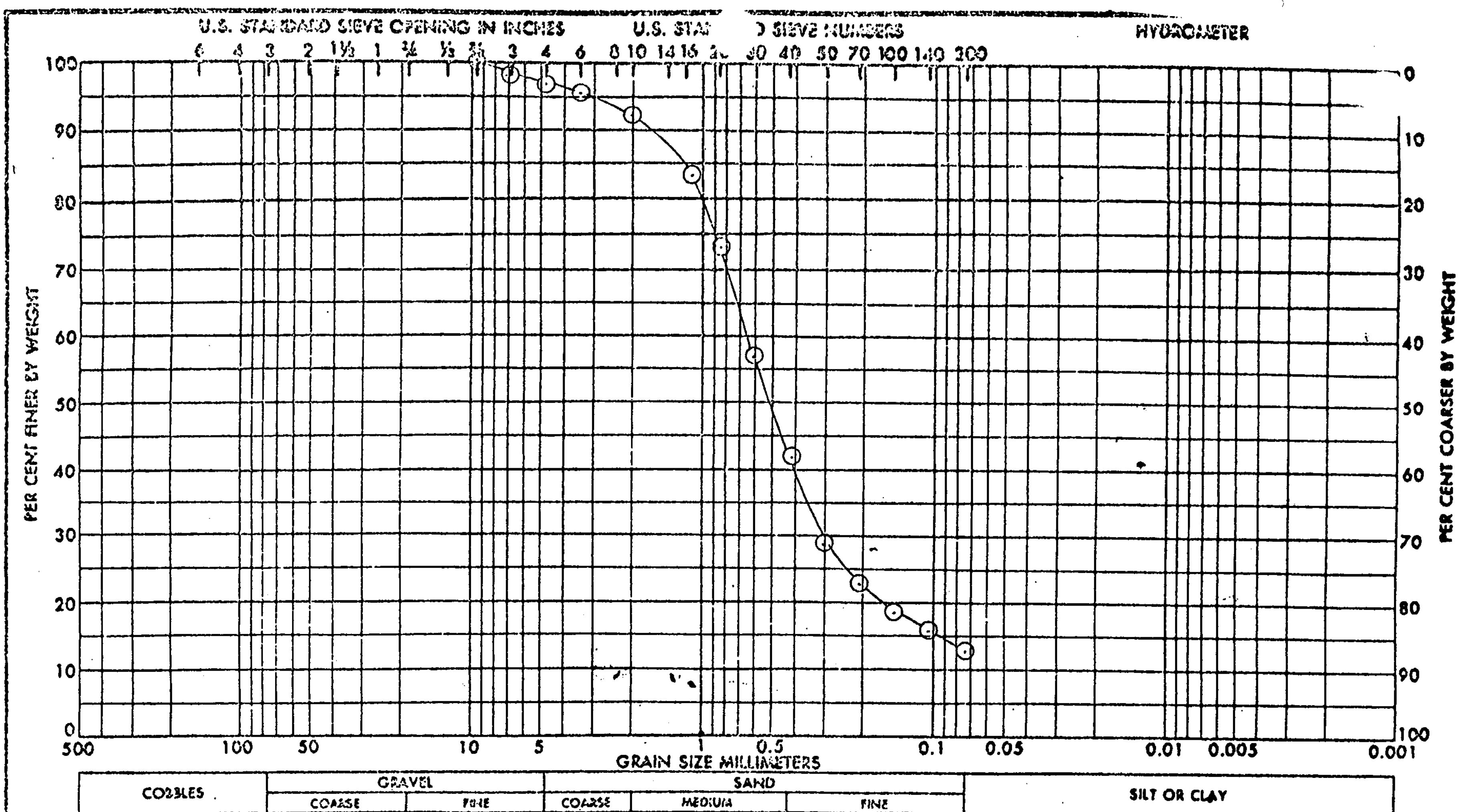
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	15.0-16.5	GRAVELLY, CLAYEY SAND(SC)	33.1	42	18	24
		Brown				
		Gs= 2.66(est)				

GRADATION CURVES

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-5
DATE	30 August, 1976

ENG FORM 2087
1 MAY 63
REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—709-128



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	10.0-11.5	CLAYEY SAND(SC)	20.0	24	17	7
		Brown				
		Gs= 2.66(est)				

GRADATION CURVES

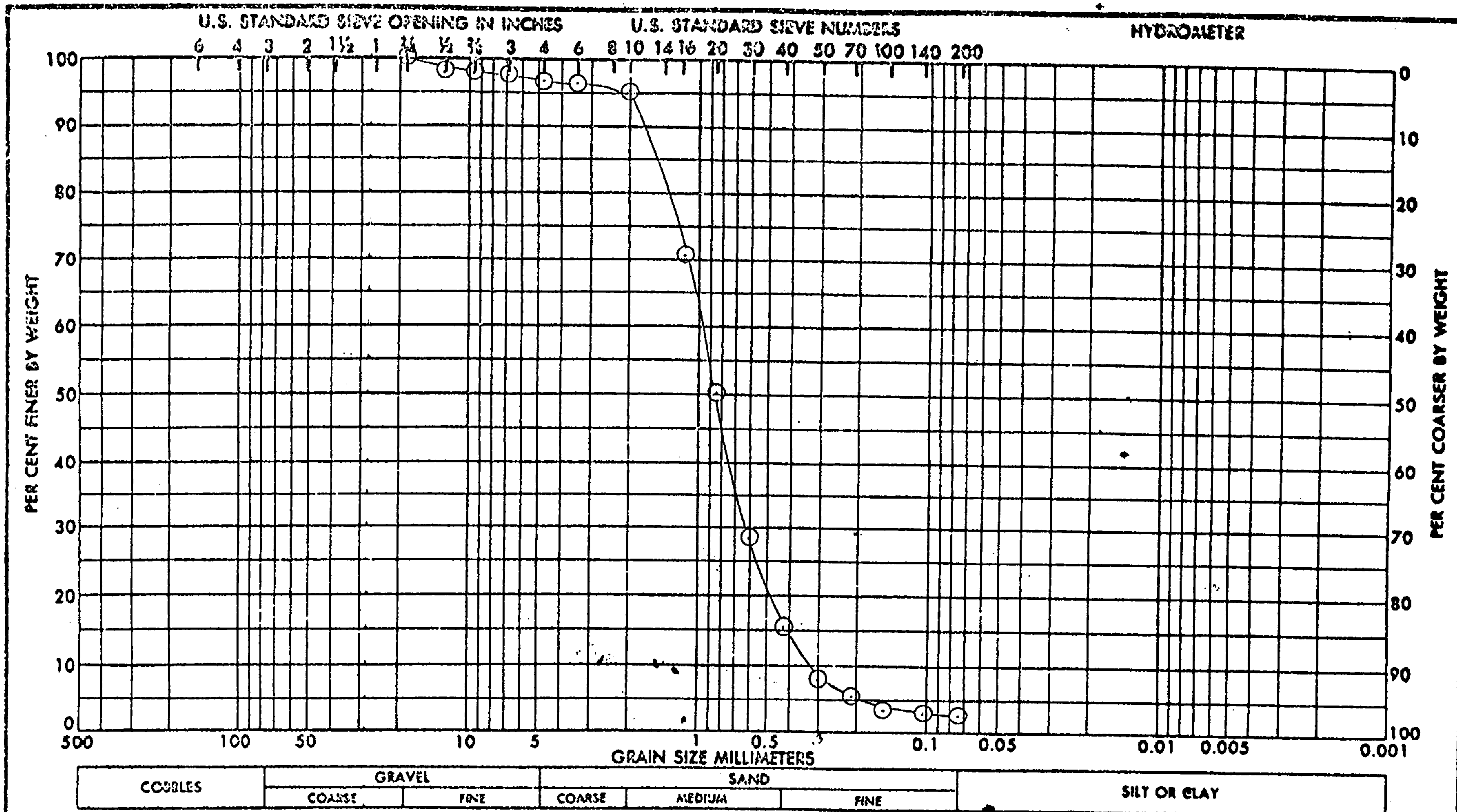
PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-6
DATE	30 August, 1976

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—760-128

Ay. D_{10} = less than 0.0
-200 = 13%



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	15.0-16.5	SAND(SP)		NP		
		Brown				
		Gs= 2.65(est)				

GRADATION CURVES

PROJECT ROCKY MOUNTAIN ARSENAL

AREA DEWATERING

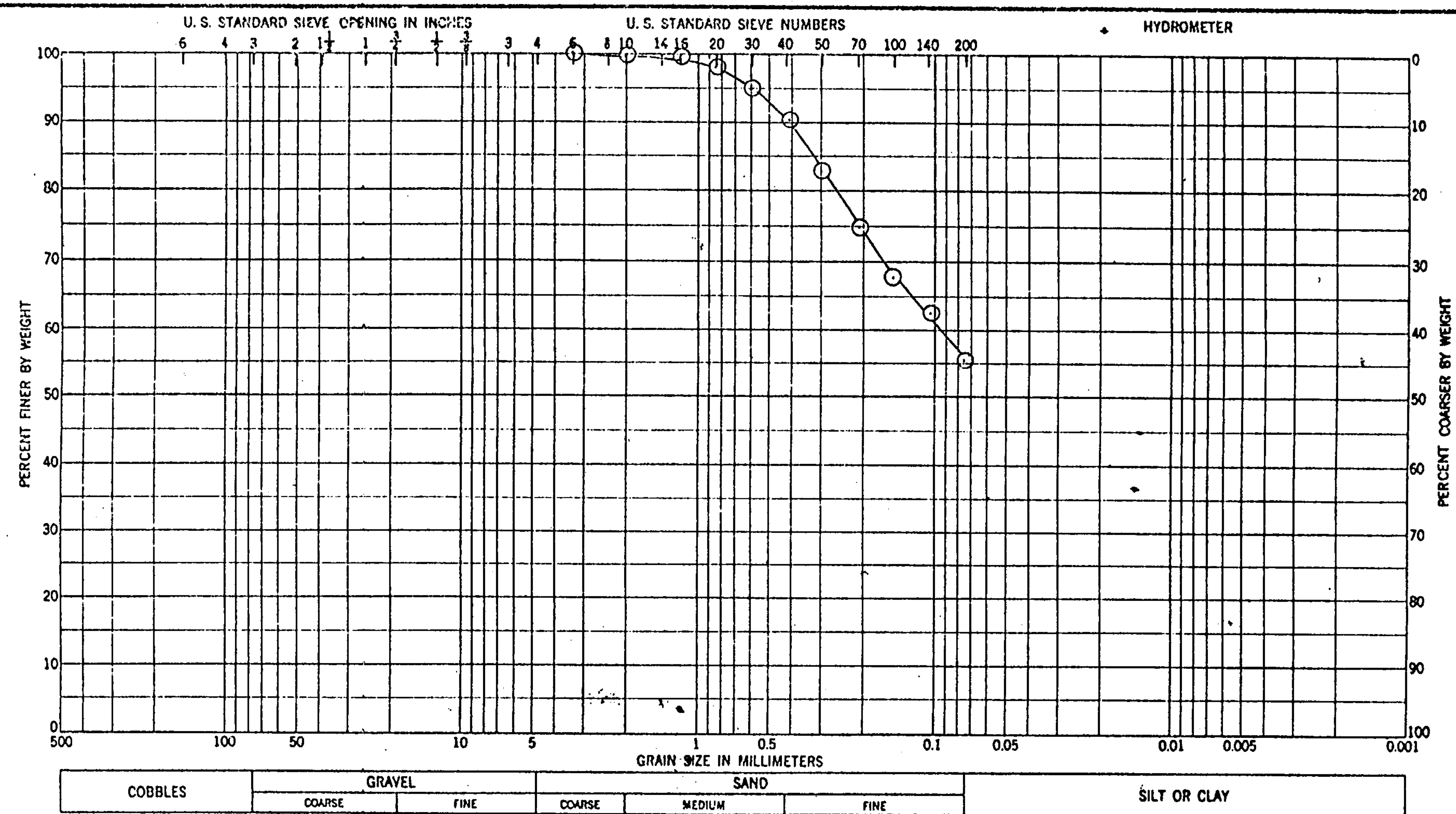
BORING NO. UD-6

DATE 30 August, 1976

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—700-186

Ag. D_{10} = 0.32
-200 = 3%

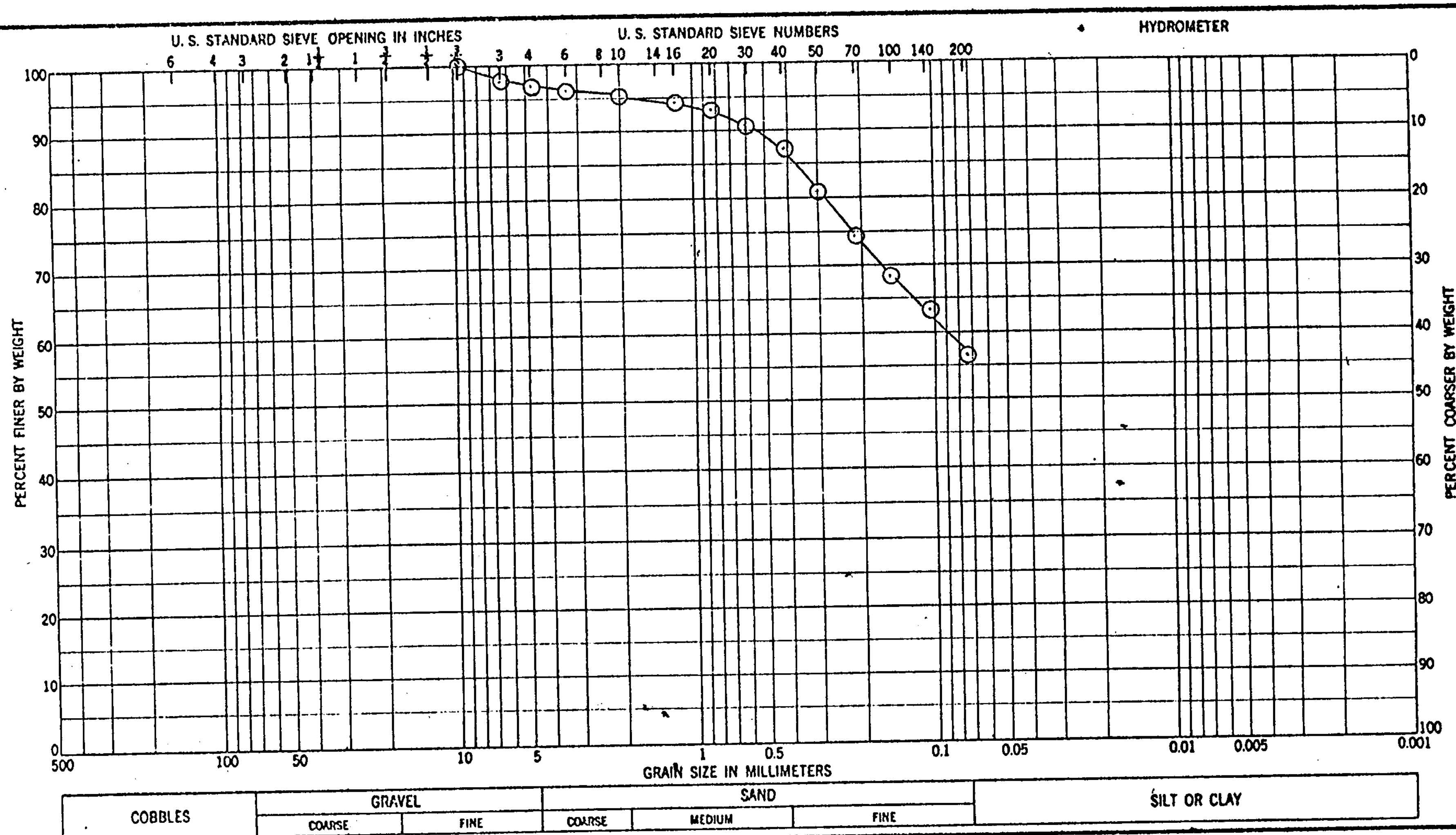


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	5.0-7.5	SANDY CLAY(CL)	19.5	32	15	17
		Brown				
		Gs= 2.67(est)				

Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	UD - 7
Date	10 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	10.0-12.5	SANDY CLAY(CL)	24.4	29	14	15
		With Gravel				
		Brown				

Project: ROCKY MOUNTAIN ARSENAL

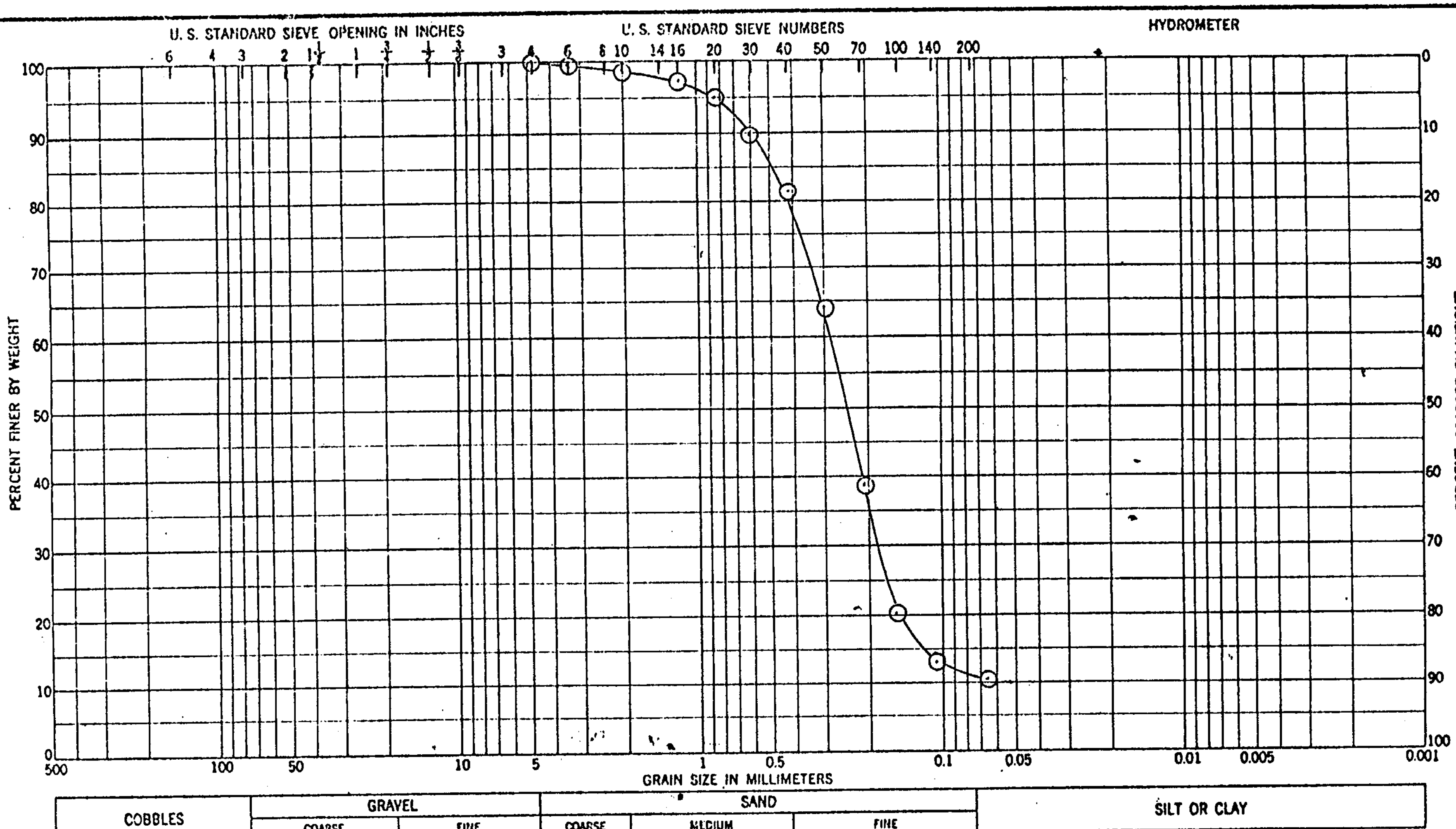
Area: DEWATERING

Boring No. UD-7

Date: 10 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	15.0-16.5	SAND(SP-SM)	26.3	NP		
		Brown				
		Gs= 2.66(est)				

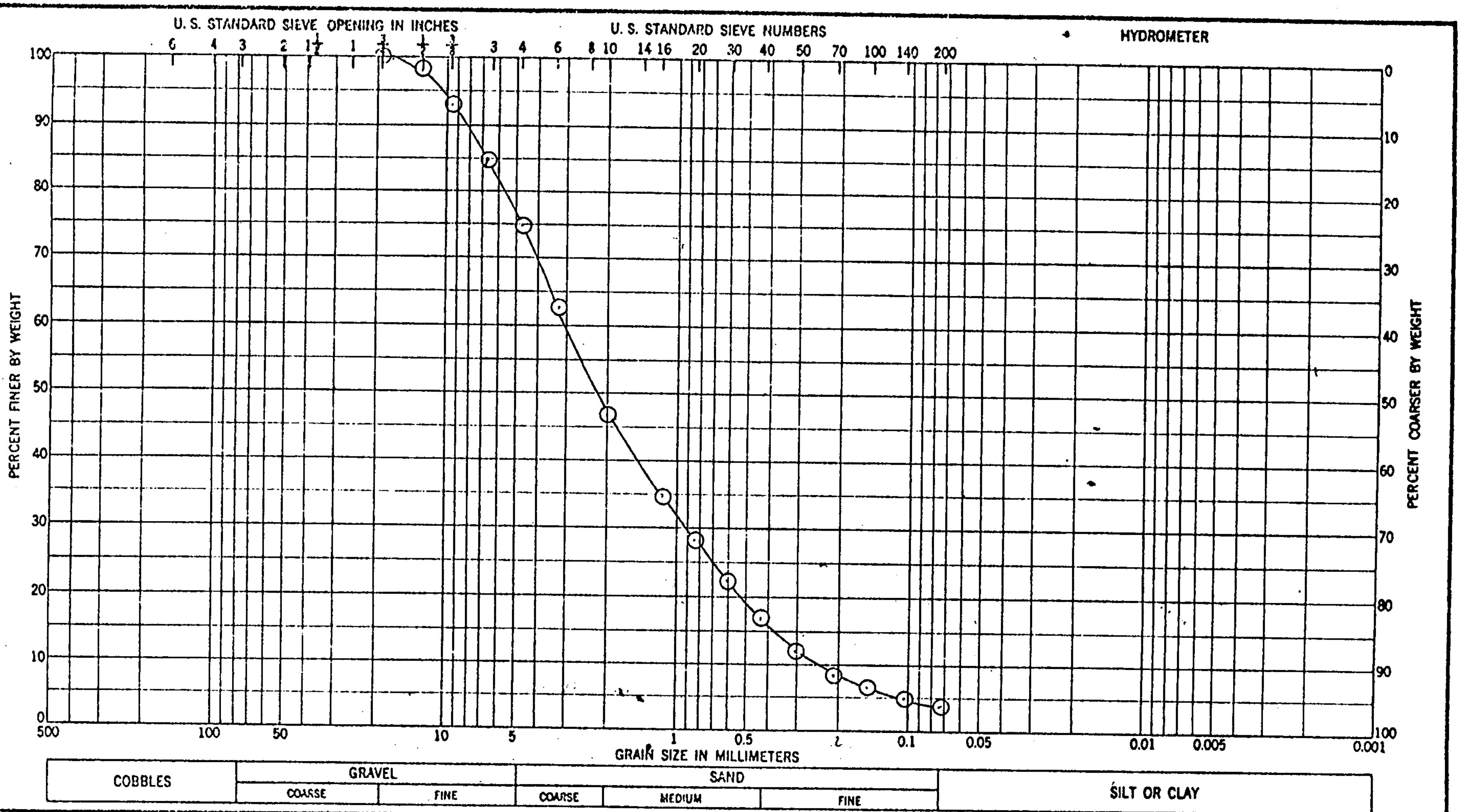
Project	ROCKY MOUNTAIN ARSENAL
Area	DEWATERING
Boring No.	UD-7
Date	10 August, 1976

GRADATION CURVES

Ag. D_{10} lessthan 0.074 m.

-200 = 11%

ENG FORM 1 MAY 63 2087



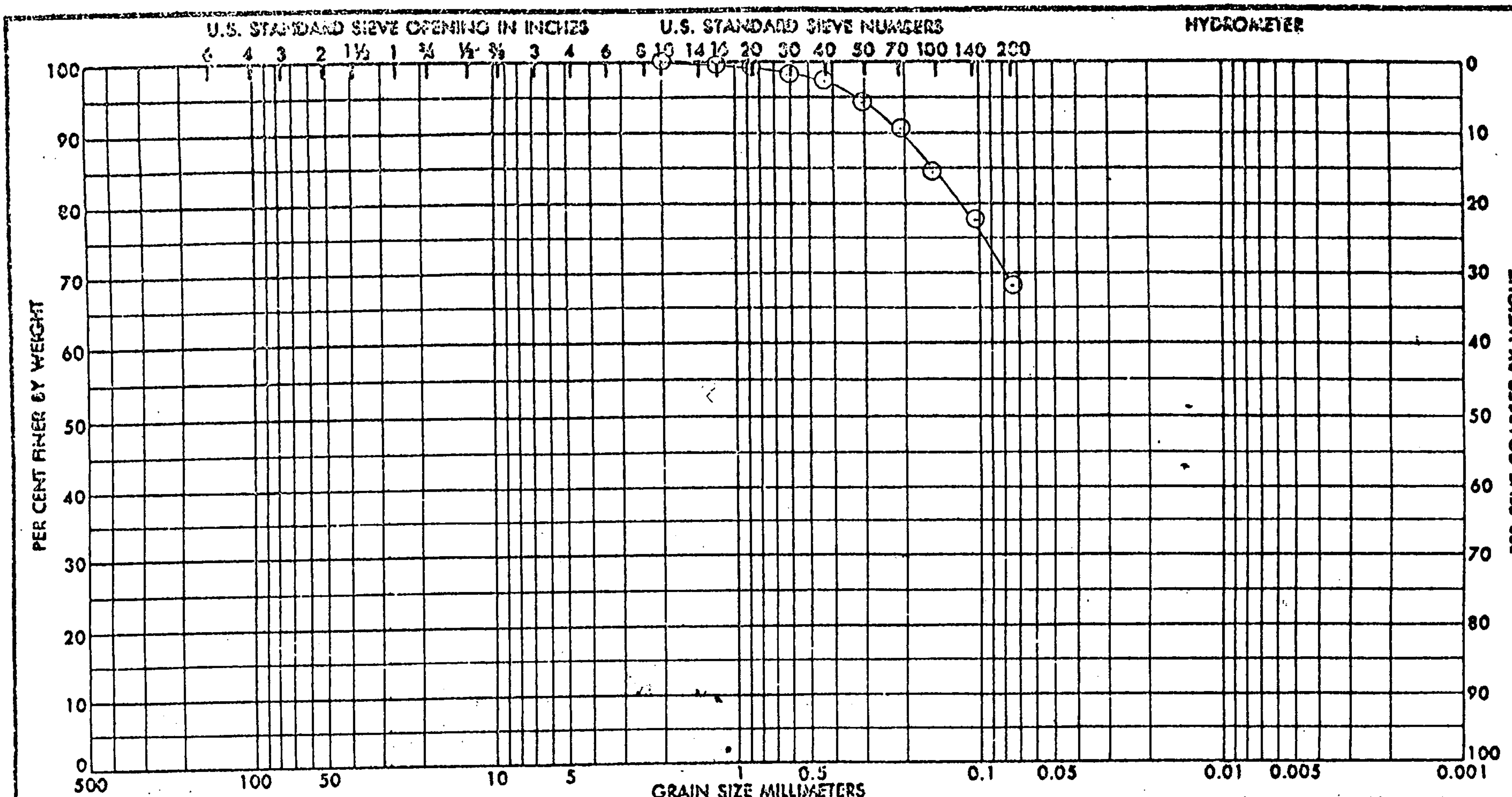
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	20.0-21.5	GRAVELLY SAND(SP)	8.7	NP		
		Brown				
		Gs= 2.65(est)				

Project ROCKY MOUNTAIN ARSENAL
Area DEWATERING
Boring No. UD-7
Date 10 August, 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Ag. $D_{10} = 0.23$
-200": 4%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1	0 - 1.5	SANDY CLAY(CL)		42	19	23
From 0		Brown				
		Gs= 2.74				

PROJECT ROCKY MOUNTAIN ARSENAL

AREA DEWATERING

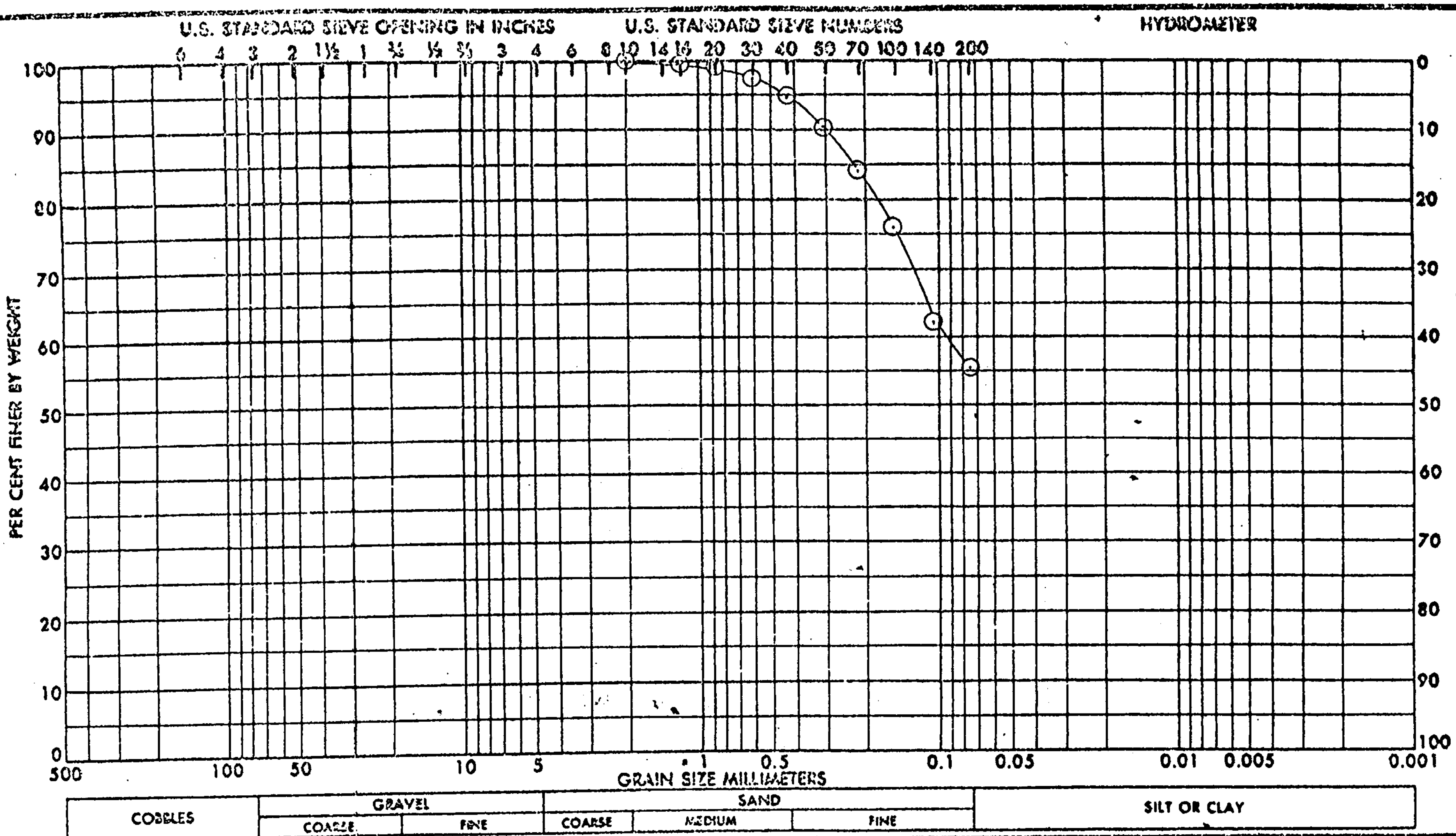
BORING NO. UD-8

DATE 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—700-180



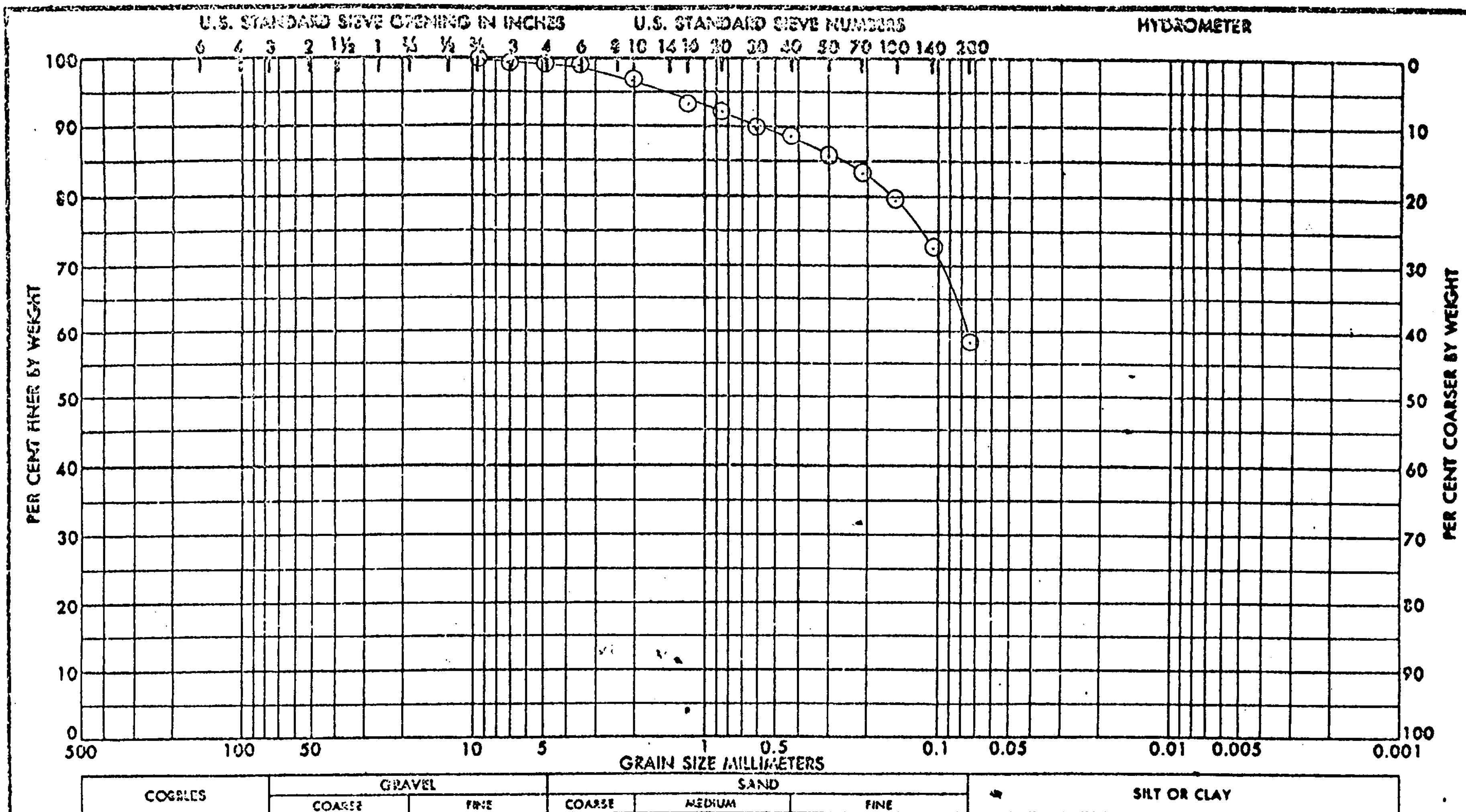
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	5 - 6.5	SANDY CLAY (CL)		25	15	10
From Density		Brown				
		Gs= 2.67(est)				

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-8
DATE	3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE . 1963 OF—700-186



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	10-11.5	SANDY CLAY(CL)				
From Density		Dark Brown				
		Gs= 2.66				

PROJECT ROCKY MOUNTAIN ARSENAL

AREA DEWATERING

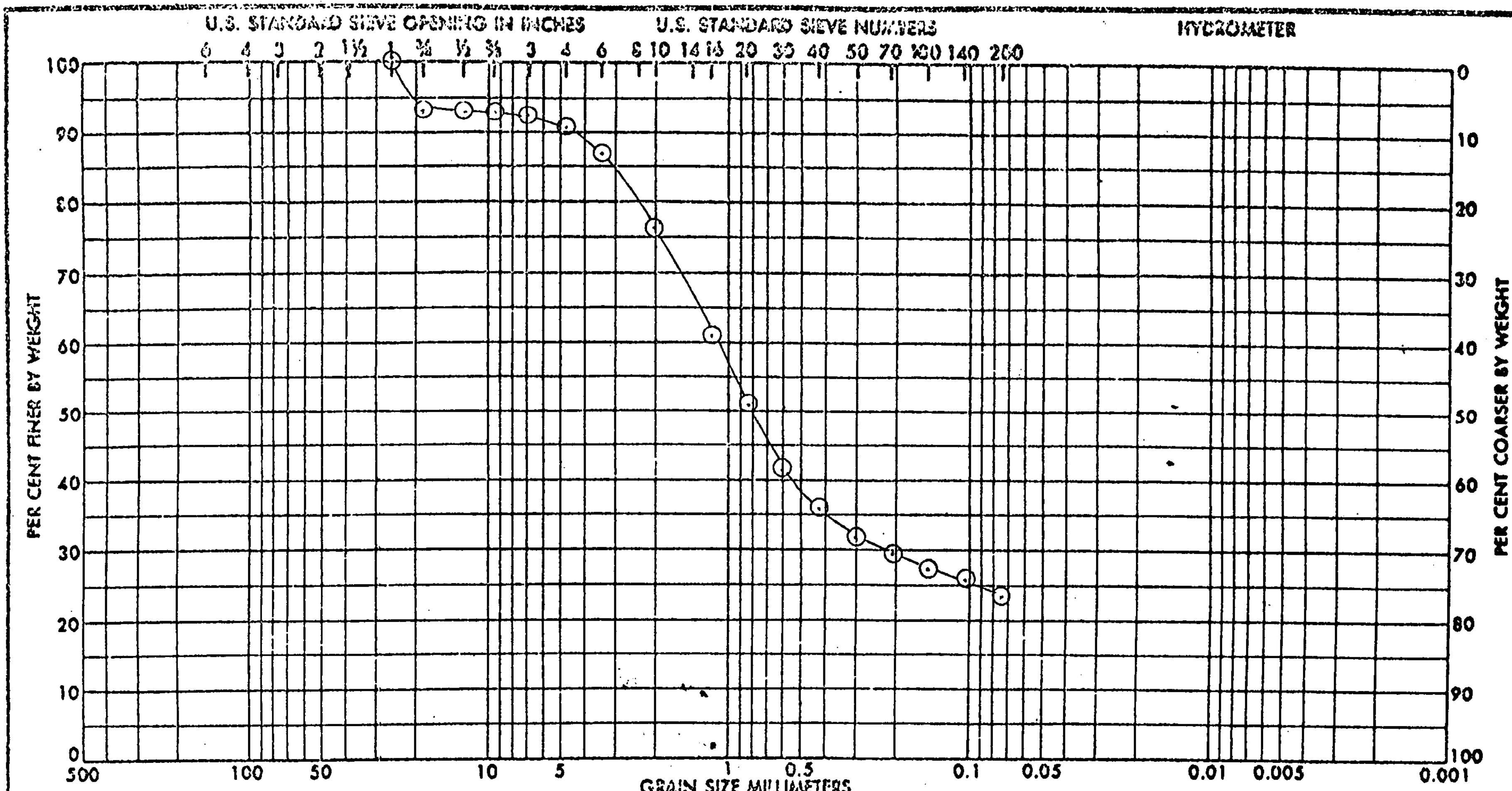
BORING NO. UD-8

DATE 3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—700-188



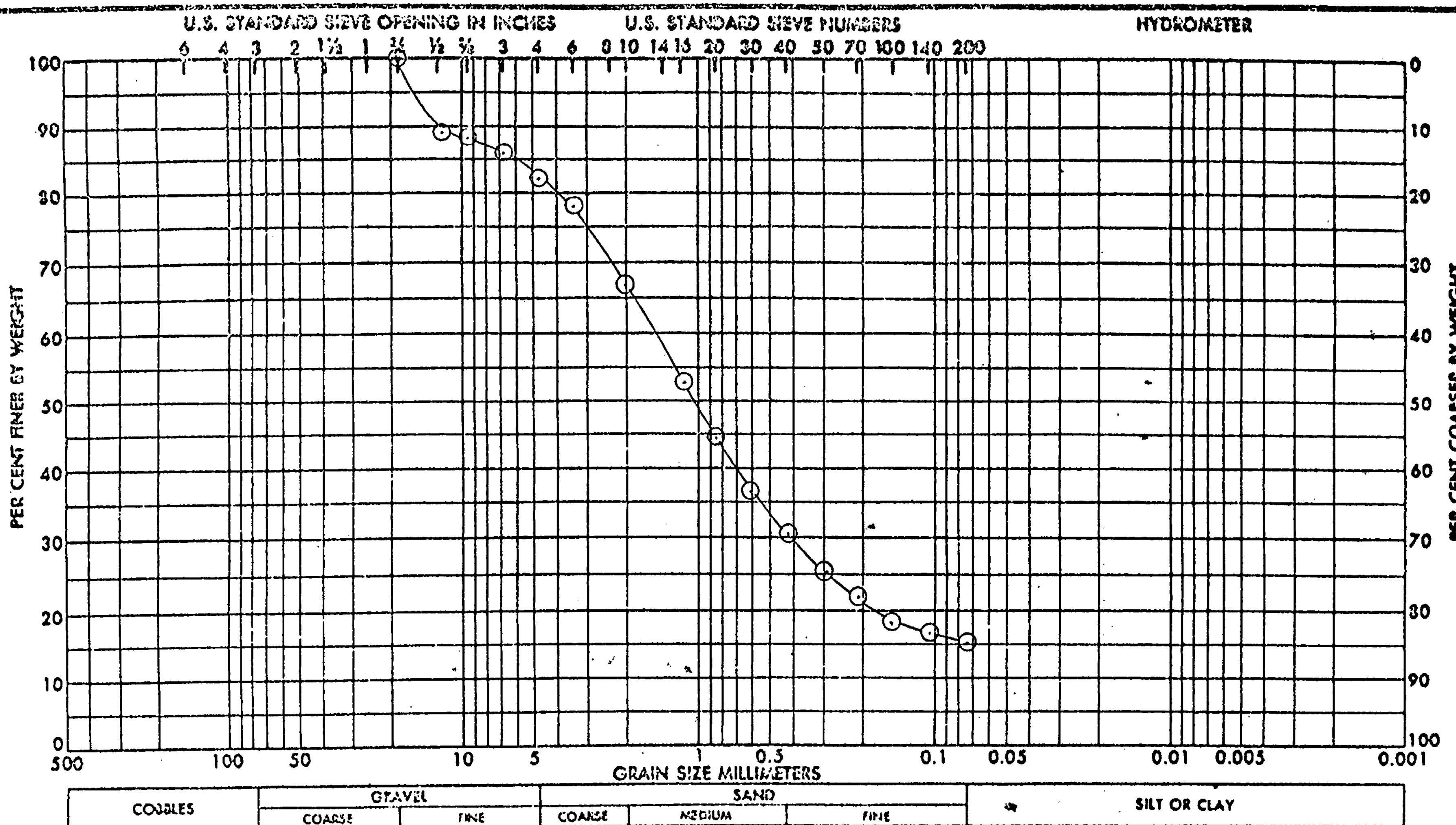
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	15.0-16.5	CLAYEY SAND (SC)	20.2	35	15	20
		With Gravel				
		Gs= 2.66(est)				
Sample too small for representative gradation						

PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-8
DATE	3 Sept., 1976

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	20.0-21.5	CLAYEY, GRAVELLY SAND(SC)	32.3	62	~22	40
		Tan				
		Gs= 2.68(est)				
Sample too small for representative gradation						

GRADATION CURVES

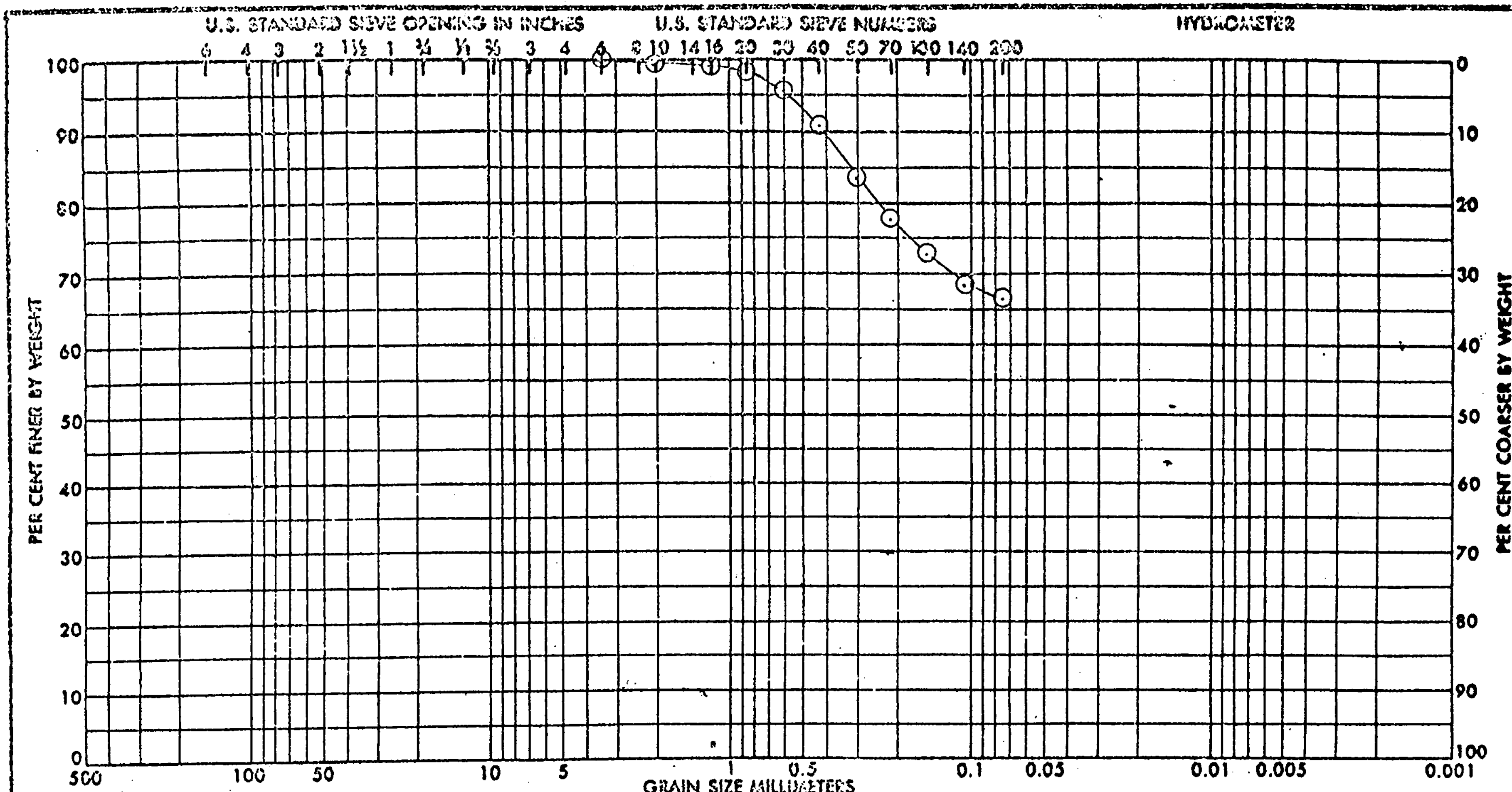
PROJECT	ROCKY MOUNTAIN ARSENAL
AREA	DEWATERING
BORING NO.	UD-8
DATE	3 Sept., 1976

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—700-128

Ag. D_{10} = less than 0.074mm
-200 = 15%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
6	25.0-26.5	SANDY CLAY(CH)	25.4	58	26	32
		Dark Gray				
		Gs= 2.70(est)				

GRADATION CURVES

PROJECT ROCKY MOUNTAIN ARSENAL

AREA DEWATERING

BORING NO. UD-8

DATE 3 Sept., 1976

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.